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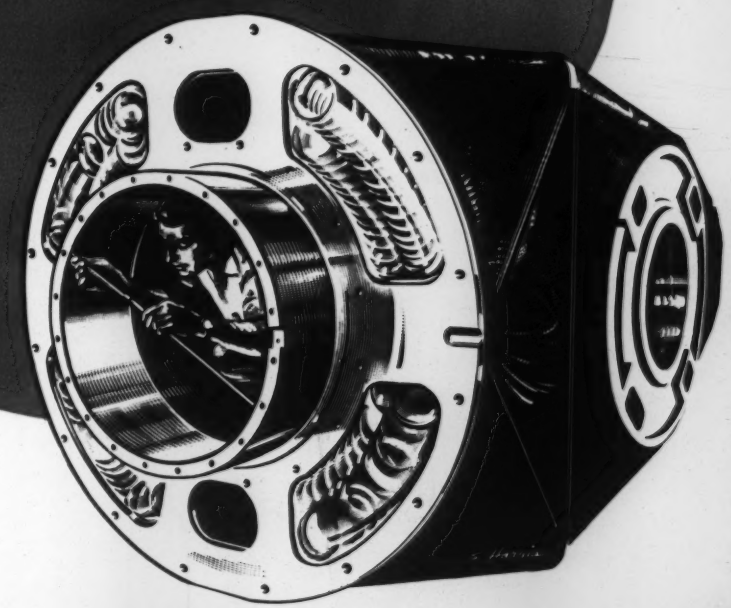
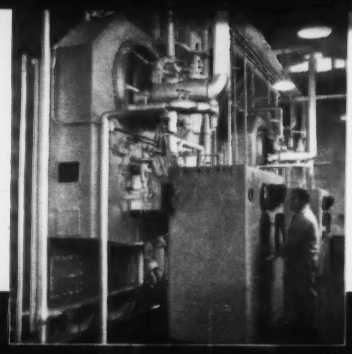
1960 ASME Winter Annual Meeting

SEE THE ASME NEWS



Close-Tolerance Machining

5 Million Cookies an Hour



Nabisco relies on B&W Package Boilers to supply heat for buildings and steam for all of their process requirements where giant ovens produce 177 million pounds of bakery products annually.

In Nabisco's $15,000,000 plant at Fair Lawn, N. J., three B&W Package Boilers are used to heat the plant, and to supply steam for process equipment. Operating at 130 psi and 338 F, the three oil-fired boilers deliver a total of 84,000 lb of steam per hour. Each of the plant's ovens are the length of a football field and these immense bake-ovens process up to 5,600,000 cookies an hour! Needless to say, dependable process steam supply is a must in this massive baking operation. That's why Nabisco selected B&W Package Boilers to provide the needed steam.

Dependability, however, is only part of the story. Budget-minded Nabisco management has found the cleanliness of operation, high fuel economies, flexibility, rapid response to demand, and maximum capacity in minimum space afforded by B&W Package Boilers equally attractive features. They also appreciate the assurance that B&W's nationwide service organization will be promptly and economically available if needed—at *any* time during the life of the boilers.

Supplying heat and process steam for a modern baking plant like Nabisco's is further evidence in action of dependable steam generation by B&W. Whatever *your* steam requirements . . . whatever your most economical fuel, B&W has the boiler best suited to your application. Your local B&W representative has all the facts on your area. Call him soon. The Babcock & Wilcox Company, Boiler Division, Barberton, Ohio.

B&W—THE NATION'S LEADING MANUFACTURER OF INDUSTRIAL BOILERS

G-979A-1B

B&W

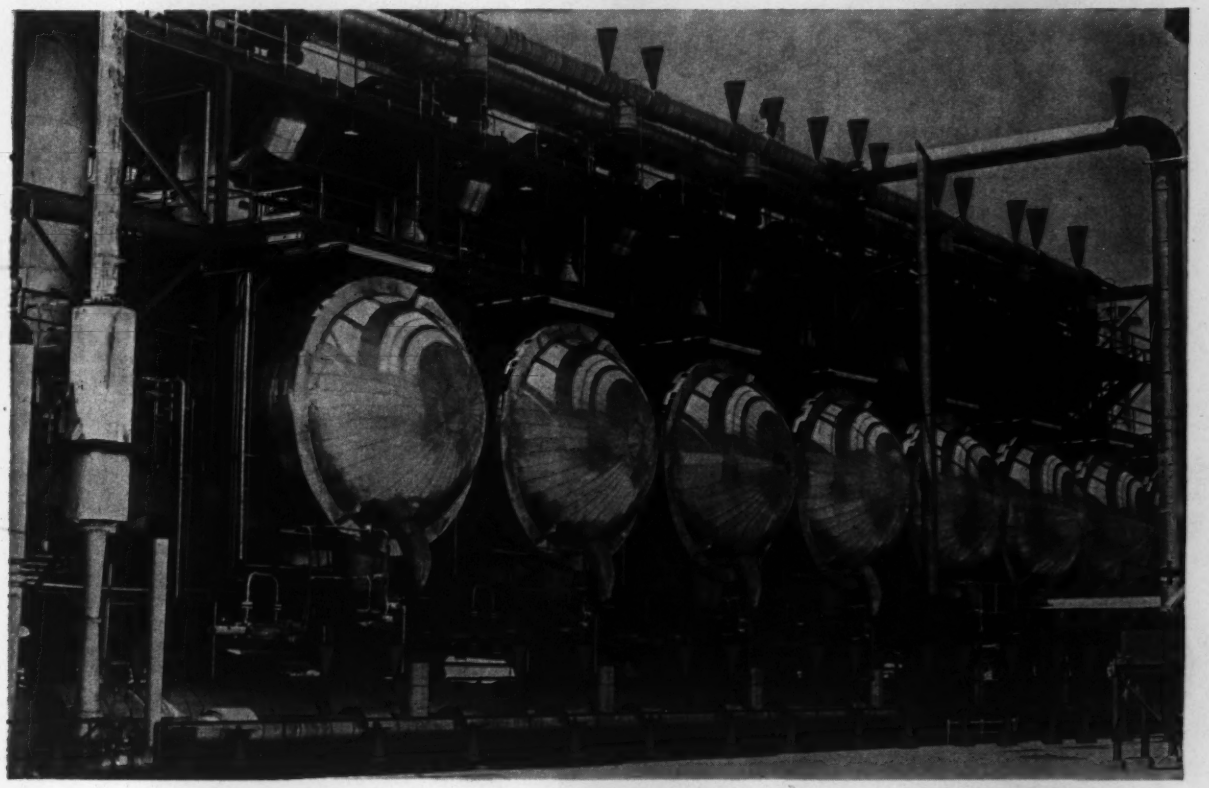
THE BABCOCK & WILCOX COMPANY

BOILER DIVISION

85½ in. dia. expansion joint connecting quench and pre-quench towers. Pinned structural ties permit expansion joint to absorb axial and differential vertical movement.

48 in. dia. expansion joint at compressor discharge. Double bellows permit large axial movement. Internal sleeve guide provides for stability, minimum pressure drop.

54 in. dia. hinged expansion joints in loop to pre-quench tower. They absorb 5⅜ in. vertical expansion and 7⅜ in. horizontal expansion due to 1200°F temperature in reactor header.



125 ZALLEA EXPANSION JOINTS, 125 demands for maximum reliability

Expansion joints, specially engineered and designed by Zallea, solve problems of space, heat and flow for Odessa Butadiene Co., Odessa, Texas.

Large-diameter piping (up to 72 in. dia.), with short, straight runs and critical flow conditions, posed new design problems. High temperature operation (1200°F) required minimum loading on sensitive equipment. Open-air construction, with few load carrying members dictated maximum stability of expansion joints with minimum use of external guides and anchors to support pipe weight and resist wind loading.

To solve these problems called for a competent, close-working team of process, piping and structural engineers from Fluor Corp. Ltd., design engineers from Odessa Butadiene Co., and application engineers from Zallea.

Result: A compact, reliable piping-expansion joint system that permitted containment of an efficient, 50,000 ton per year unit in an area whose largest dimension is a few hundred feet.

This is another example of how Zallea experience in handling critical, complex Expansion Joint applications can save time and money. For more facts, call us . . . or write for catalog 56.

ZALLEA BROTHERS, Taylor and Locust Sts., Wilmington 99, Del.

Zallea **FOR MAXIMUM RELIABILITY**

WORLD'S LARGEST MANUFACTURERS OF EXPANSION JOINTS

New Series of Marsh Needle Valves in 316 STAINLESS STEEL

—Valves that take you out of your corrosion problems

Now still wider service range for the valves that have set new standards in the needle throttling field. A full line of Marsh Needle Valves are immediately available in 316 stainless steel in the new series 1936.

Identified by blue handles

Here is a valve that opens up the wide range of corrosion-resistant applications bracketed by 316 stainless. It is a valve that gives precision throttling at pressures from a few pounds through 6000 psi . . . a valve for any temperature from minus 100° F. to plus 500° F. thanks to the "Marpak" packing system making use of precision moulded Teflon.

Only Marsh experience—in both valve making and instrument making—could have produced these valves. Like other Marsh needle valves, they are available in globe and angle patterns and in panel mounted types; sizes, ⅛″, ¼″, ⅜″, ½″, ¾″ and 1″. The 316 stainless valves are fully described in Bulletin NV-3.

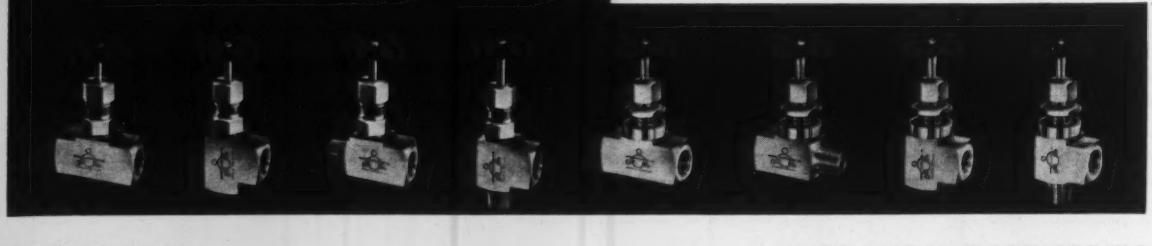
Marsh Needle Valves are also available in 416 stainless steel (identified by green handles) and in mild steel (identified by yellow handles.)

The Marsh touch—
the precision touch—in every detail

- Body and stem guide machined from 316 stainless bar stock.
- Accurately machined stem, precision ground and rolled.
- Longer inlet and outlet thread chambers insure tight make-up.
- Packing as corrosion-resistant as the valve.

MARSH *Needle Valves*

MARSH INSTURMENT COMPANY, Dept. 29, Skokie, Ill.
Division of Colorado Oil and Gas Corporation
Marsh Instrument & Valve Co. (Canada) Ltd.
8407 103rd St., Edmonton, Alberta
Houston Branch Plant, 1121 Rothwell St.,
Sect. 15, Houston, Texas



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THE COVER

This 4200-lb aluminum weldment will become a traverse housing for the missile-tracking system of the Army's Nike-Zeus program. Boeing Airplane Company's Wichita, Kan., Division did the machining under subcontract from Continental Can Company, this being one of a series of large prototype parts machined by Boeing. Surfaces at opposite ends were machined to a tolerance of 0.002 in., while other surfaces had to be held to 0.0002 in. The centerline axes of holes at right angles had to cross within 0.001 in.

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Listen, some time, to an earnest engineer talking to management. Root for him to make his point. Wish him skill with words and ideas. But the engineer's presentation may be a study in futility.

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MADE BY MEN WHO KNOW METALLURGY

B&W Welding Fittings manufacturing is integrated with the Division's facilities for research, development, product quality control and testing, as well as those for steel and tube-making. Take the relation between metallurgy and the manufacture of fittings. B&W not only knows fittings manufacturing, but is able to control, completely, all phases of the manufacturing process . . . starting with the melting of the steel. Integration plus metallurgical knowledge and practice makes for superior fittings. It enables B&W to provide a quality-controlled product, matched to end use service.

B&W Welding Fittings and Flanges are available through qualified welding fittings distributors in carbon steel and the B&W CROLOYS in a complete range of types and sizes. Write for B&W Bulletin FB-502. The Babcock & Wilcox Company, Tubular Products Division, Fittings Plant, P.O. Box 230, Beaver Falls, Pennsylvania.

B&W

THE BABCOCK & WILCOX COMPANY

TUBULAR PRODUCTS DIVISION

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Seamless and welded tubular products, solid extrusions, seamless welding fittings and forged steel flanges—in carbon, alloy and stainless steels and special metals

MECHANICAL

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KODAK ANNOUNCES 3 IMPORTANT NEW

Superb, high-contrast emulsions now ON ESTAR BASE

Now you can meet the job at hand with intermediates that are as tough as they come and have exceptionally sharp detail.

Big new plus in these 3 films is Kodak's Estar Base which gives much longer life and greater dimensional stability to reproductions of drawings, maps, documents.

These new Estar Base films are highly translucent for fast "print back". . . have an excellent matte surface on both sides for easier drafting . . . won't turn yellow or become brittle . . . and are resistant to moisture. Available in popular cut-sheet sizes and in rolls up to 52 inches wide.

---

1. Kodagraph Autopositive Film, ESTAR BASE
Ideal choice for general reproduction work—gives you same-size positive intermediates directly without a negative step . . . can be exposed and processed in room light. Excellent results from print-through and reflex printing—even when reflexing from metal templates.

2. Kodagraph Contact Film, ESTAR BASE
Bound to be a darkroom favorite in making same-size reproductions of old or weak line drawings and other documents from film or low-cost paper negatives. Exposures are made with standard contact printers. Processing done with either paper or litho developers. Exceptionally wide latitude of this film all but ends make-overs.

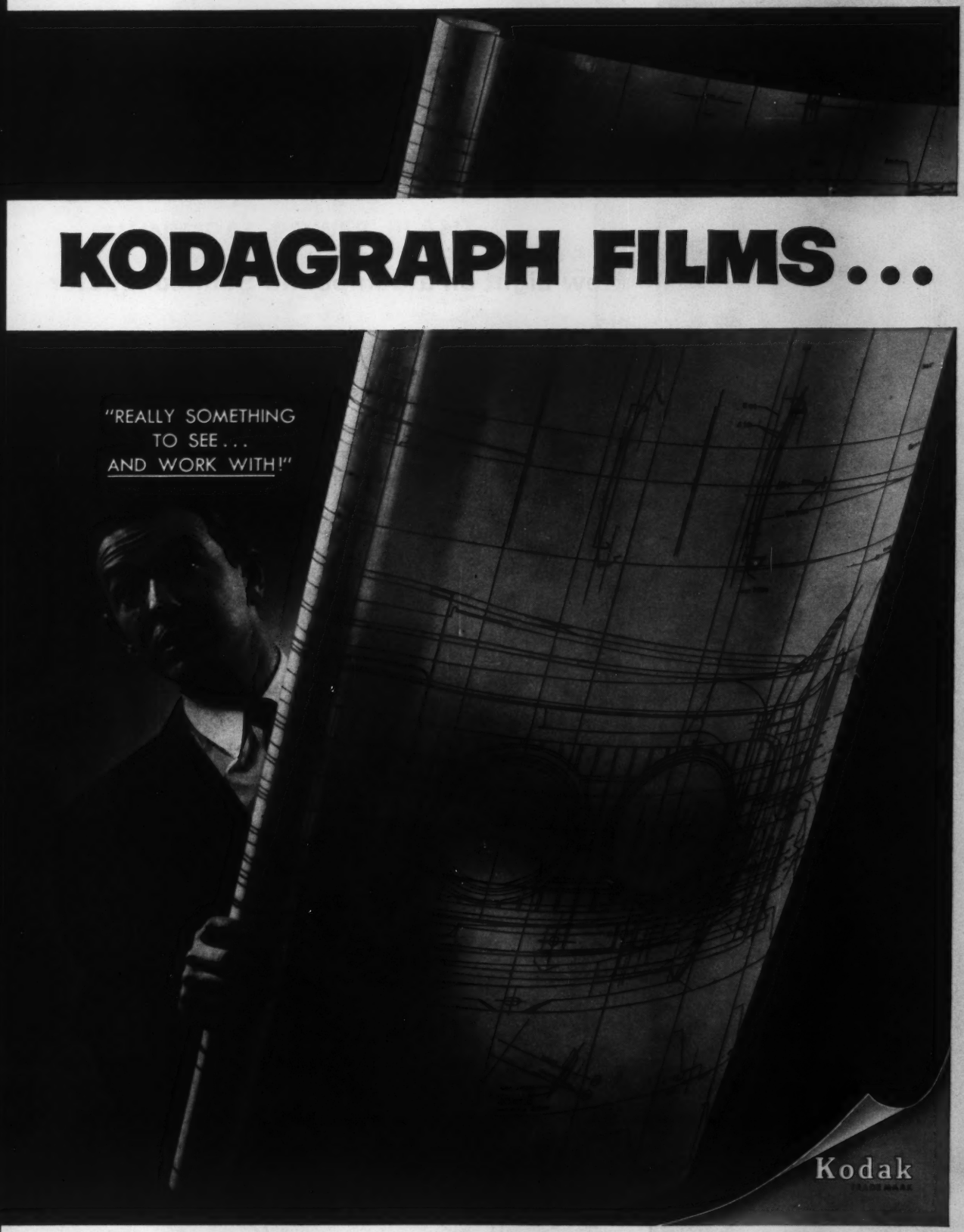
3. Kodagraph Projection Film, ESTAR BASE
Changing scale is easy with this high-contrast, quick-processing film. It gives you sharp, clean results when enlarging microfilm negatives, or reducing large drawings, blueprints, maps. Can be handled with "1A" safelight, and exposed in enlargers, projection printers, process cameras.

Really something every engineer, draftsman, and blueprinter should get full details on now. Call your local Kodagraph dealer for free literature, or write to Eastman Kodak Company, Graphic Reproduction Division, Rochester 4, N.Y.

NEW! Kodagraph

REPRODUCTION FILMS

KODAGRAPH FILMS...



One of a series

New Light on a Compound Semiconductor

Pictured is a new and unusual transistor . . . made from a *compound* semiconductor. Its electronic properties are greatly affected by *light*. It is a *field-effect* transistor having input impedances up to 100 megohms (versus 1,000 ohms for junction transistors). Its unique combination of properties has enabled it to perform some novel circuit functions not possible with other transistors.

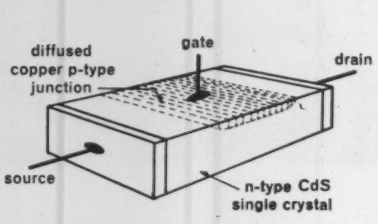
Still in the early experimental stage, this phototransistor is a tangible result of the General Motors Research Laboratories' program on semiconductors — particularly the group II-VI compound, cadmium sulfide. Behind its development lies the steady accumulation of (1) know-how in crystal growing, doping, and contact preparation and (2) information about CdS's intriguing solid state properties (red or green luminescence, high photoconductivity, short relaxation times, etc.).

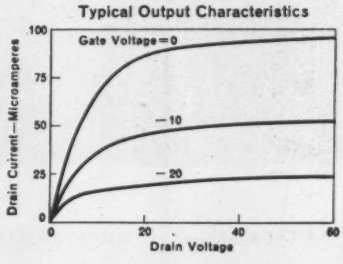
For the researcher, this three-terminal device is adding a new dimension to the fundamental understanding of semiconductors. For instance: GM Research scientists have uncovered the important role of photo-generated holes in modulating the conductance of this intrinsic semiconductor and have determined the hole drift mobility through a new theoretical analysis.

These semiconductor investigations illustrate the dual aim of GM Research: contributions to the science, advances in the technology of important new subject areas. Such research is the initial step in General Motors' continuing quest for "more and better things for more people."

General Motors Research Laboratories

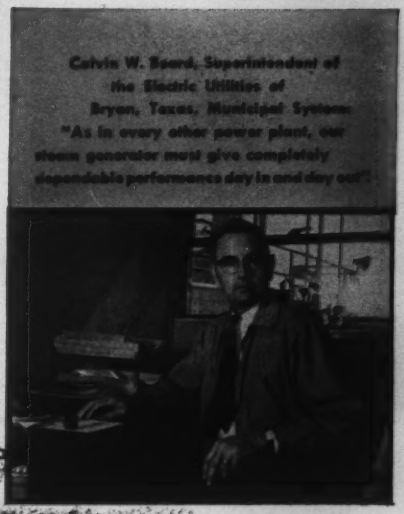
Warren, Michigan



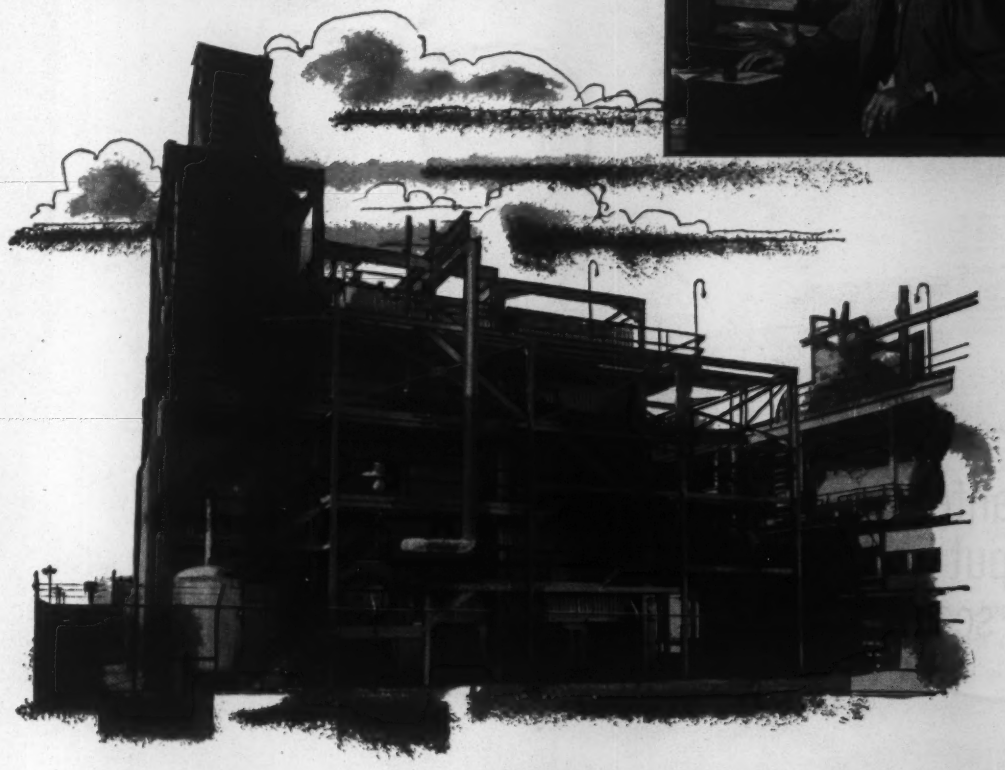


NEW WICKES STEAM GENERATOR

insures maximum efficiency and dependability for BRYAN, TEXAS, MUNICIPAL POWER PLANT



Calvin W. Beard, Superintendent of the Electric Utilities of Bryan, Texas, Municipal System: "As in every other power plant, our steam generator must give completely dependable performance day in and day out".



This Wickes Type RB 2 drum boiler is designed to produce 220,000 lbs. of steam per hour at 875 psig and 900° total steam temperature for the city of Bryan, Texas. The unit performs not only with remarkable dependability, but with Wickes' usual efficiency and economy. Wickes Boiler Co. builds steam generators in sizes to 500,000 lbs. of steam per hour, for high or low steam pressures and temperatures and for all types of fuels and firing methods. See your nearest Wickes representative for full information on a Wickes steam generator designed to suit your needs.

WICKES

RECOGNIZED QUALITY SINCE 1854

Sales Offices: Atlanta • Boston • Charlotte, N.C. • Chicago • Cleveland Dallas • Denver • Detroit • Houston • Indianapolis • Los Angeles • Memphis • Milwaukee • New Orleans • New York City • Philadelphia • Portland, Ore. • Rochester, N.Y. • Saginaw • San Francisco • Seattle, Wash. Springfield, Ill. • Tulsa

Bulletin 55-1 gives details of a wide variety of designs and sizes of Wickes field-erected and shop-assembled steam generators. Write for your free copy.

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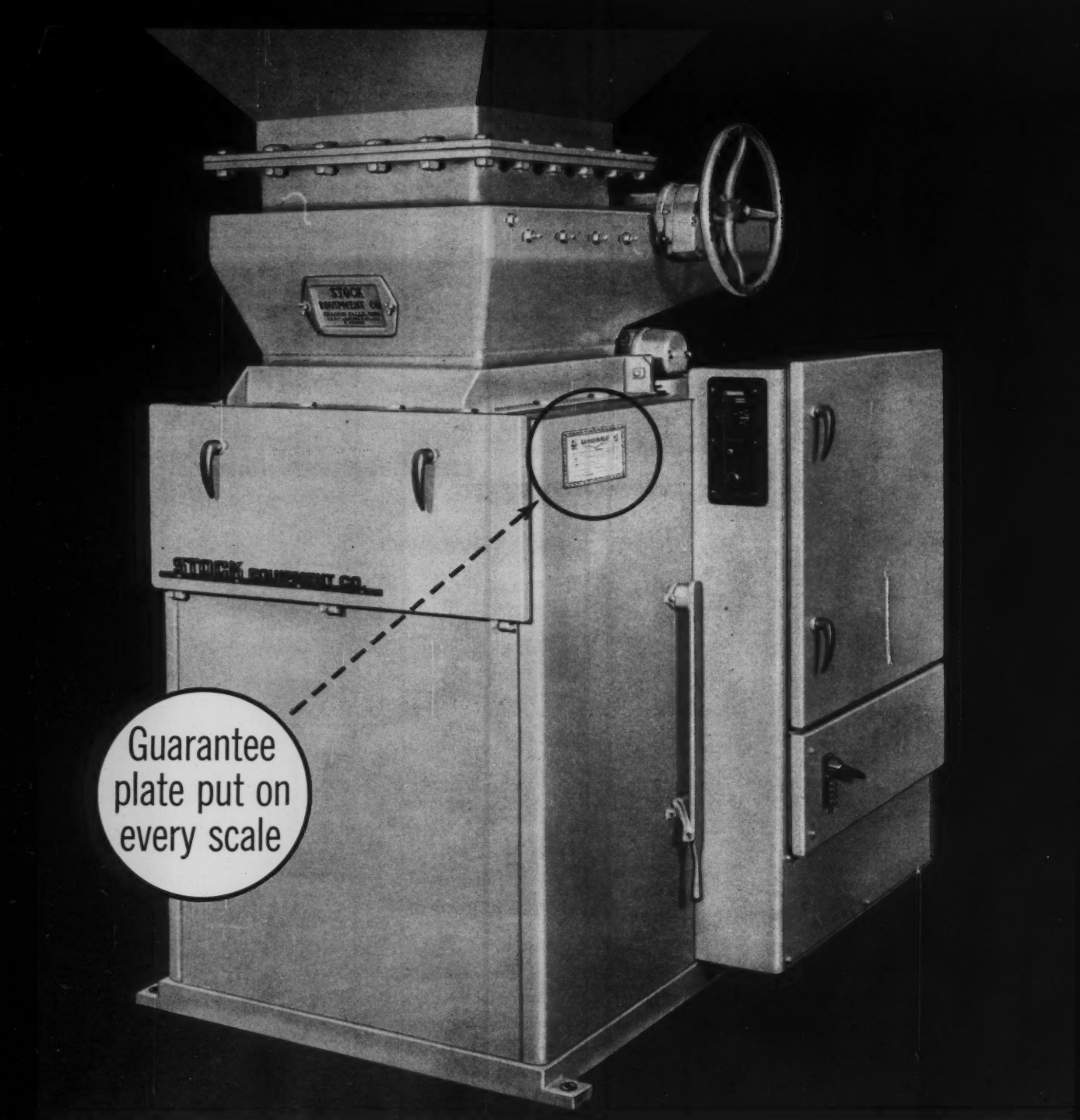
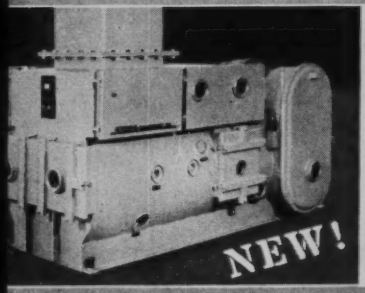
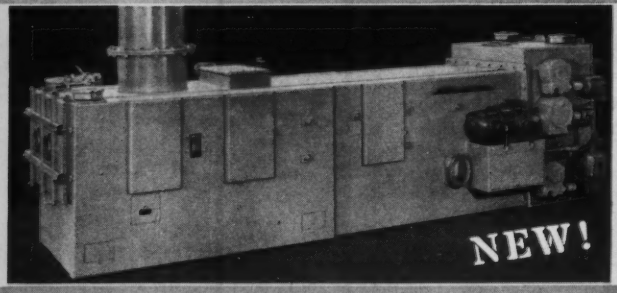
WICKES BOILER CO., SAGINAW 13, MICHIGAN, DIVISION OF THE WICKES CORPORATION



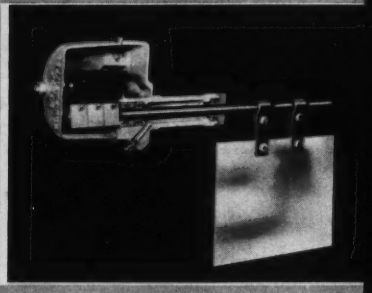
S-E-Co. QUALITY PRODUCTS



GRAVIMETRIC FEEDERS
Weigh and Feed



VOLUMETRIC FEEDERS
Feed Sticky Coals

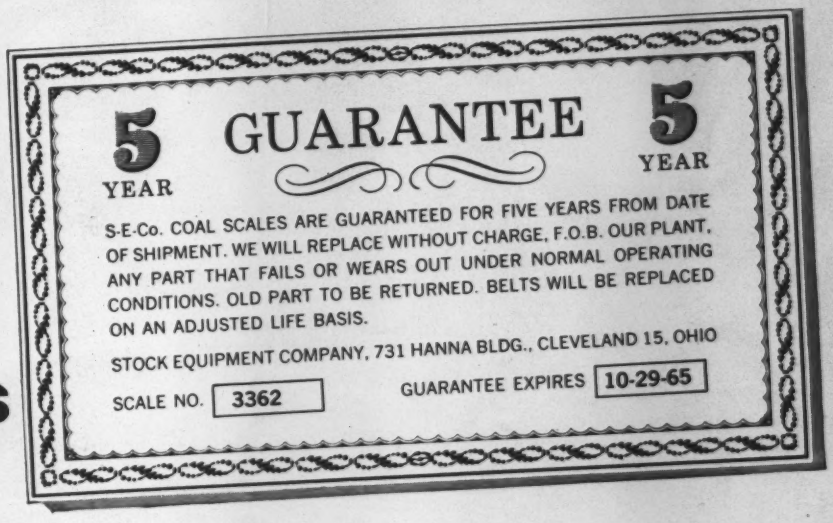


STOPPAGE ALARMS
Two Types

STOCK EQUIPMENT COMPANY

NOW GUARANTEES

S-E-Co. COAL SCALES FOR 5 YEARS


5 YEAR
GUARANTEE
5 YEAR
S-E-Co. COAL SCALES ARE GUARANTEED FOR FIVE YEARS FROM DATE OF SHIPMENT. WE WILL REPLACE WITHOUT CHARGE, F.O.B. OUR PLANT, ANY PART THAT FAILS OR WEARS OUT UNDER NORMAL OPERATING CONDITIONS. OLD PART TO BE RETURNED. BELTS WILL BE REPLACED ON AN ADJUSTED LIFE BASIS.
STOCK EQUIPMENT COMPANY, 731 HANNA BLDG., CLEVELAND 15, OHIO
SCALE NO. 3362
GUARANTEE EXPIRES 10-29-65

S-E-Co. Scales have always been built to last, with a minimum of Maintenance, the life of the boiler plant. Analysis of repair parts sold during the first five years of life indicates that the dollars of parts sold per year is very small – most of these parts were for stock purposes. No parts for any purpose whatever were sold for 25% of the scales.

Stock Equipment Company, to prove the quality of S-E-Co. Coal Scales now guarantees S-E-Co. Scales for a 5-year period. This is being done without any price change since the expected cost of this guarantee is almost zero.

This guarantee applies to all scales shipped after October 1, 1960. The guarantee, etched on a plate, will be attached to each scale in plain sight so the man who buys parts knows of its existence.

For your next coal scale job why not buy the top quality. Buy S-E-Co. with a 5-year guarantee.

STOCK EQUIPMENT COMPANY

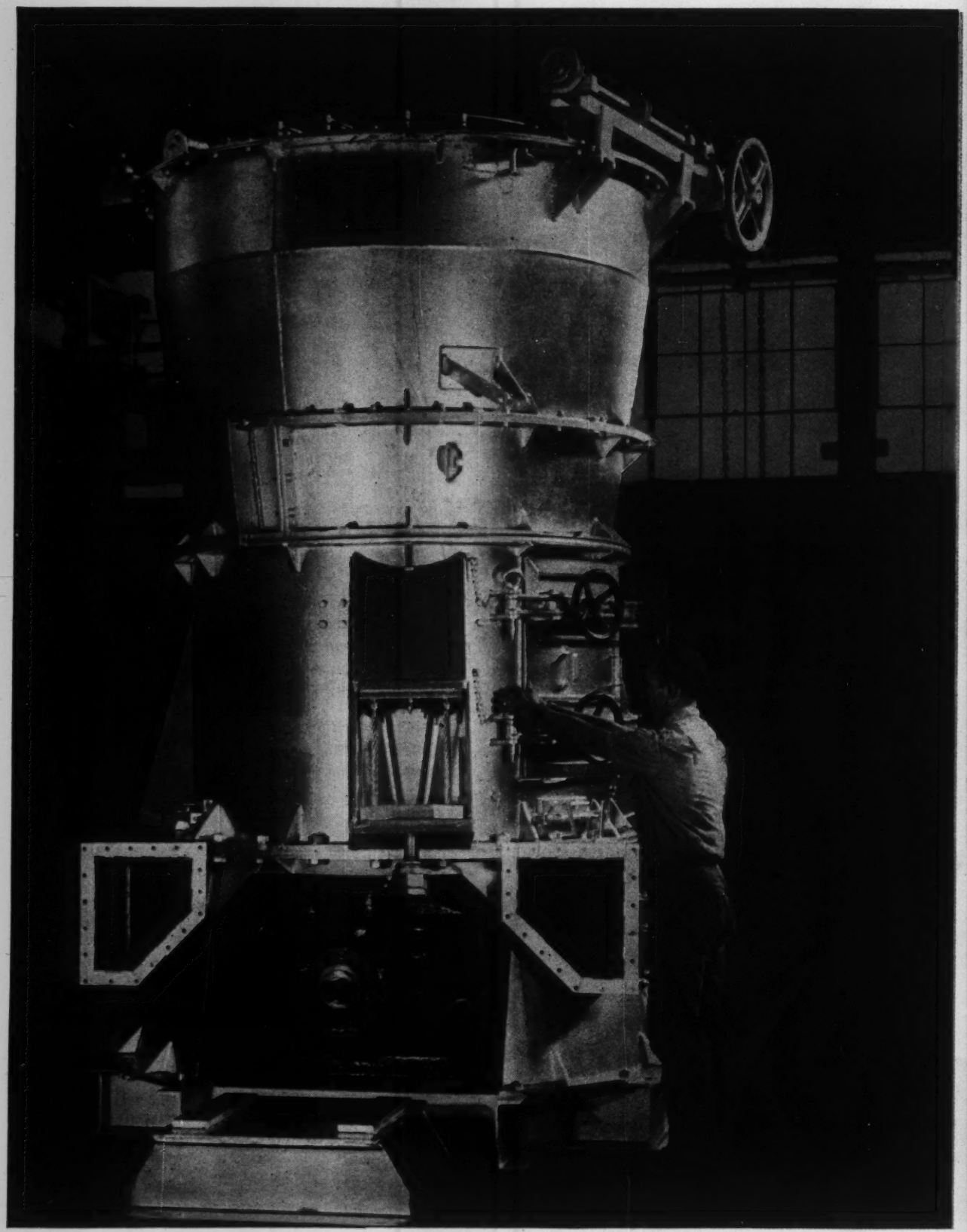
729 HANNA BUILDING • CLEVELAND 15, OHIO

S-E-Co. QUALITY PRODUCTS

CONICAL NON-SEGREGATING COAL DISTRIBUTORS

COAL SCALES
Two Basic Sizes

COAL VALVES
6" to 60" – Many Styles



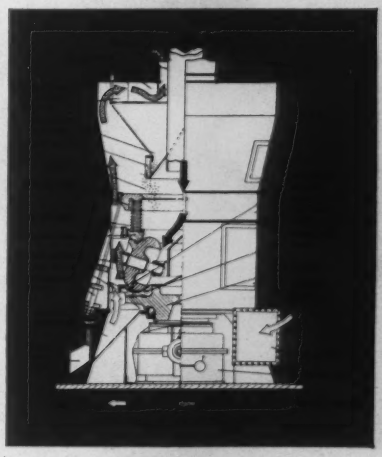
Foster Wheeler MB planetary roll and table pulverizer. Available with capacities from 2 ton/hr to 55 ton/hr.

Foster Wheeler MB Pulverizer, SIMPLE...VERSATILE...RELIABLE

The best combination of advantages for a wide range of fuel requirements

COMPARISON: Foster Wheeler MB pulverizer compared with two other leading pulverizers (A & B) available in U.S.

Power consumption	equal to A & B
Availability	better than A, equal to B
Accessibility	better than A & B
Floor Space	equal to A & B
Flexibility for suction or pressure operation	equal to A, better than B



European power companies have used the MB pulverizer for over 10 years. Low power consumption, low maintenance and the extremely high availability of the design are thoroughly proven.

Now further refined by FW engineers, and tested for two years in the U.S., the MB pulverizer deserves careful consideration in planning any fuel system which may require mill capacities from 2 to 55 tons of pulverized fuel per hour.

The MB design is extremely simple, providing reliability and ease of maintenance. The only moving parts inside the grinding area are three spheroidal rollers, a roller guide, and the powered horizontal grinding table. All adjustments can be made with the mill in operation.

The planetary motion of the rollers maintains uniform product fineness. Wear of grinding surfaces is extremely slow. The rollers and carrier need no lubrication. Noise and vibration levels are very low.

Provision is made for either pressurized or suction operation. In addition to coal pulverizing, the MB mill is also available for grinding gypsum, cement, solid chemicals, pigments, food products and other commercial materials.

Write for Bulletin MB-58-1, giving more detailed specifications for the MB mill. Foster Wheeler Corporation, 666 Fifth Avenue, New York 19, N. Y.

FOSTER WHEELER

NEW YORK LONDON PARIS ST. CATHARINES, ONT.

PICK YOUR IMPELLER, PICK YOUR PUMP

Of course, you never bought an impeller and then bought the pump later. But 'pick your impeller, pick your pump' is one way of suggesting you put *performance* before *standardization*.

Sure, we can give you pumps from a complete standardized line. We can, for example, show you how four basic frames are used in six different pump types and 127 different models. And we can show you one bearing that spins in 51 different sizes, or one shaft that turns in 39 sizes. So far as we know, there's no more standardized line of centrifugal pumps than this.

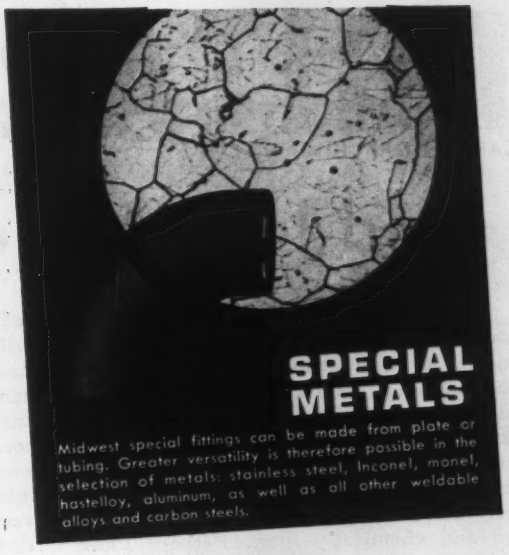
But we can't help reminding you that the day-to-day economy of any pump lies in its operating efficiency plus how close it comes to meeting your exact performance requirements. Only after these conditions are met does a minimum number of parts lying in your storeroom really count.

So, to you it's most important that this line of Worthington SESC pumps contains more (not less) different types of impellers than any other line. It contains open, closed and semi-open impellers. Each is available in five different materials to handle abrasive or corrosive materials, water or slurries. In fact, because of the extensive impeller selection, this line offers a 'customerized' pump selection meeting more specific performance requirements than any other line.

But don't take our word for it. Take a look at the SESC pump line. You'll see it's standardized to the nth degree in ratings up to 3000 gpm and 550 ft. heads. But there are more impellers to choose from . . . thus you can buy a custom built pump at standard prices.

For the name of your nearest Worthington distributor consult the Yellow Pages or write Worthington Corporation, Section 20-18, Harrison, New Jersey.

WORTHINGTON



SPECIAL METALS

Midwest special fittings can be made from plate or tubing. Greater versatility is therefore possible in the selection of metals: stainless steel, Inconel, monel, hastelloy, aluminum, as well as all other weldable alloys and carbon steels.

MIDWEST SPECIAL FITTINGS MADE BY FITTING SPECIALISTS TO YOUR SPECIAL REQUIREMENTS

SPECIAL SHAPES

Midwest's wide experience and skills with forging presses and dies permit forming plate or tubing into unusual shapes for special applications . . . elbows with or without long tangents, wyes, extrusions, and other special configurations.

For special fittings with any or all of the above characteristics, contact your local Midwest distributor . . . or call:

MIDWEST

MIDWEST PIPING COMPANY, INC.

1450 S Second St. • St Louis 4, Mo. • MAin 1-8308

SPECIAL THICKNESS

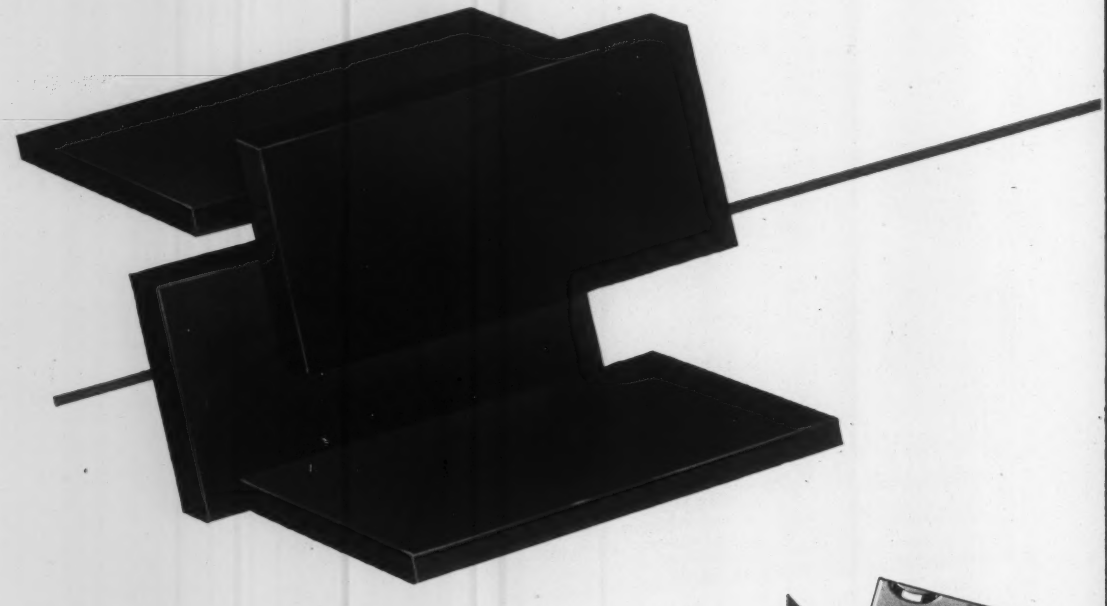
Wall thicknesses in a wide range of sizes are available in Midwest special fittings, up to 4" or more in carbon steel and a wide variety of alloys . . . stainless steel, Inconel, titanium, and others.

GRAPHITAR® VANES

(CARBON-GRAPHITE)

and long life of CONDE

This rotary positive displacement pump, engineered and produced by the Dri-Air Pump Department of the Conde Milking Machine Company, Inc., of Sherrill, N. Y., is designed to deliver clean, dry air or gas for high vacuum and low pressure applications in hospitals, dental offices, chemical or pharmaceutical plants, industrial processing systems and in metalworking plants. Thanks to vanes of GRAPHITAR, the CONDE Dri-Air Pump gives years of trouble-free, continuous operation at maximum recommended vacuum and speed . . . *without lubrication!* The GRAPHITAR pump vanes are self-lubricating and are seated by centrifugal force. Operating with a minimum of friction, they become increasingly efficient as the pump is used. In addition to their self-lubricating properties, the GRAPHITAR vanes are hard, light, non-sticking, non-warping and chemically inert. Perhaps these qualities can be utilized to advantage in your products.



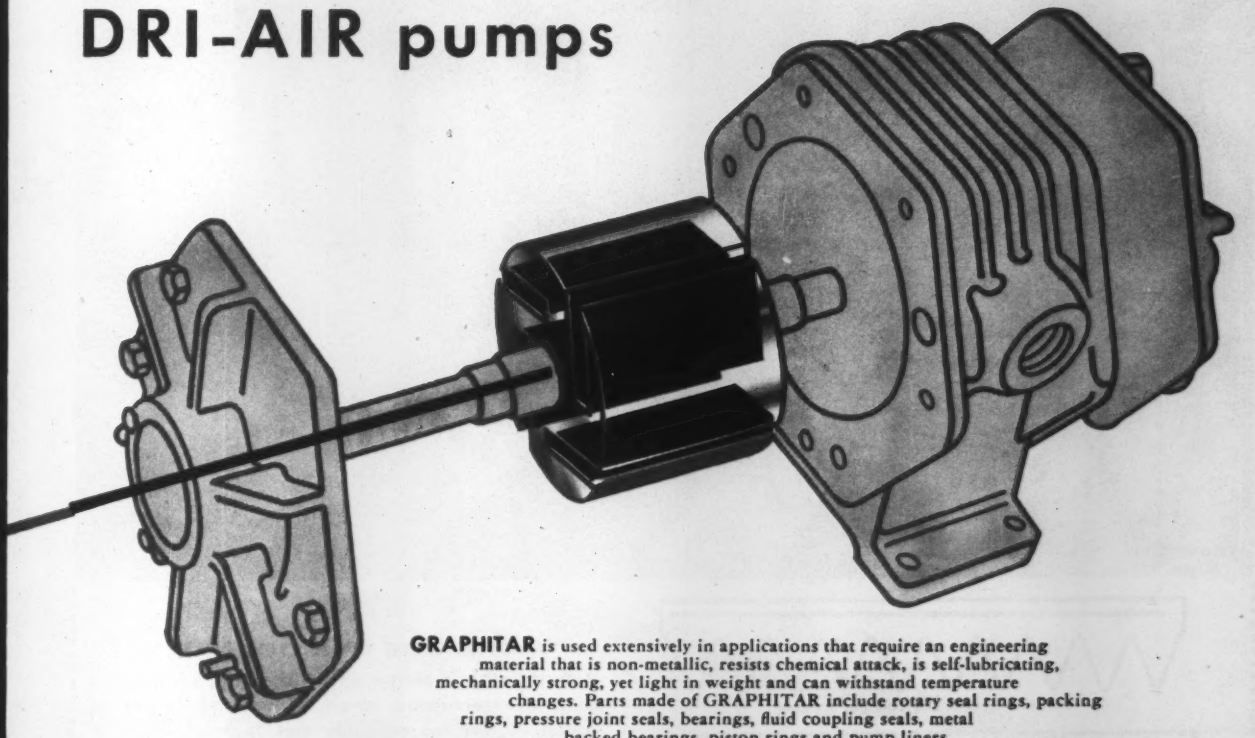
Bulletin #20 includes detailed design data along with properties, characteristics and typical applications of GRAPHITAR. Write for your free copy. If you have questions concerning the incorporation of GRAPHITAR parts in your products, our engineers will be glad to assist you.

THE UNITED STATES

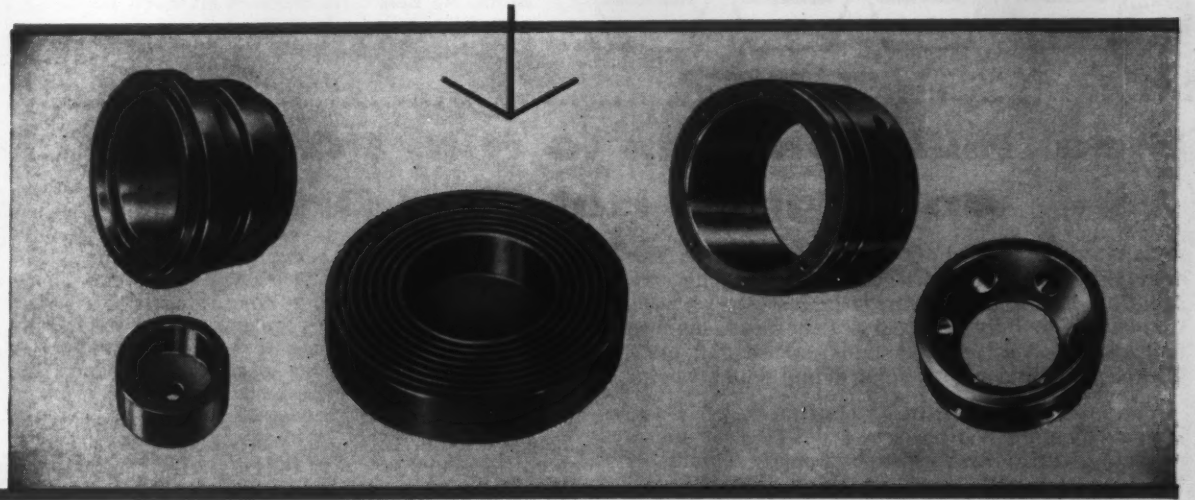
GRAPHITAR® CARBON-GRAPHITE • GRAMIX® POWDER METALLURGY • MEXICAN® GRAPHITE PRODUCTS • USG® BRUSHES

help insure efficiency

DRI-AIR pumps



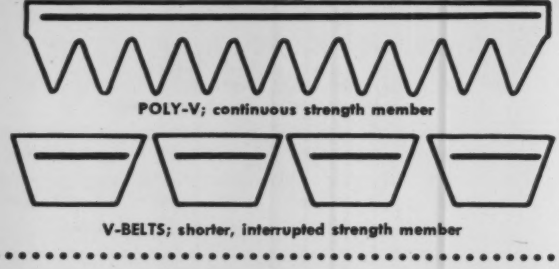
GRAPHITAR is used extensively in applications that require an engineering material that is non-metallic, resists chemical attack, is self-lubricating, mechanically strong, yet light in weight and can withstand temperature changes. Parts made of GRAPHITAR include rotary seal rings, packing rings, pressure joint seals, bearings, fluid coupling seals, metal backed bearings, piston rings and pump liners.



R-285-2

GRAPHITE COMPANY

DIVISION OF THE WICKES CORPORATION, SAGINAW 4, MICHIGAN



"MORE USE PER DOLLAR"

Poly-V Belt is a single unit with even, uniform pull. Uninterrupted strength member gives much higher hp capacity per inch of drive width. No belt drive delivers as much power in the same space as Poly-V!

Steel Mill Converts to R/M POLY-V BELT on Rugged Hot-Saw Drive!

A 34½" wide R/M Poly-V® Belt of 92 ribs now delivers "power plus" on this punishing hot-saw drive at one of the country's largest steel works. Converting to Poly-V eliminates the problems of a multiple V-belt drive . . . matching, stretching, overloading, whipping and snapping of individual V-belts.

The patented Raybestos-Manhattan Poly-V Drive is a single unit, V-ribbed belt design that mates perfectly with Poly-V sheave grooves, eliminates V-belt stretch and length matching problems . . . reduces costly machine downtime and production slowdowns for individual belt replacement. Sheave ratio and belt position remain constant from *no* load to *full* load . . . assure smooth, *complete* power delivery under the toughest drive conditions. Poly-V Belt can't sink in the grooves under surges of load. This means less wear on belts and sheaves . . . and much more power in the same space as a multiple belt drive—or equal power in much less space!

Just two Poly-V Belt cross-sections meet every heavy duty drive requirement. Let an R/M representative show you how Poly-V Drive can give you greater power-packed performance and drive dependability . . . "More Use per Dollar" than the drive you now use. Write for Bulletin M141.

RM1020

When You Change Drives . . . Convert to R/M Poly-V Drive and Be Sure!

RAYBESTOS-MANHATTAN, INC.

MANHATTAN RUBBER DIVISION, PASSAIC, NEW JERSEY

RM

ENGINEERED RUBBER PRODUCTS . . . MORE USE PER DOLLAR

BJ Boiler Feed Pumps

Quality *costs less* in the long run!

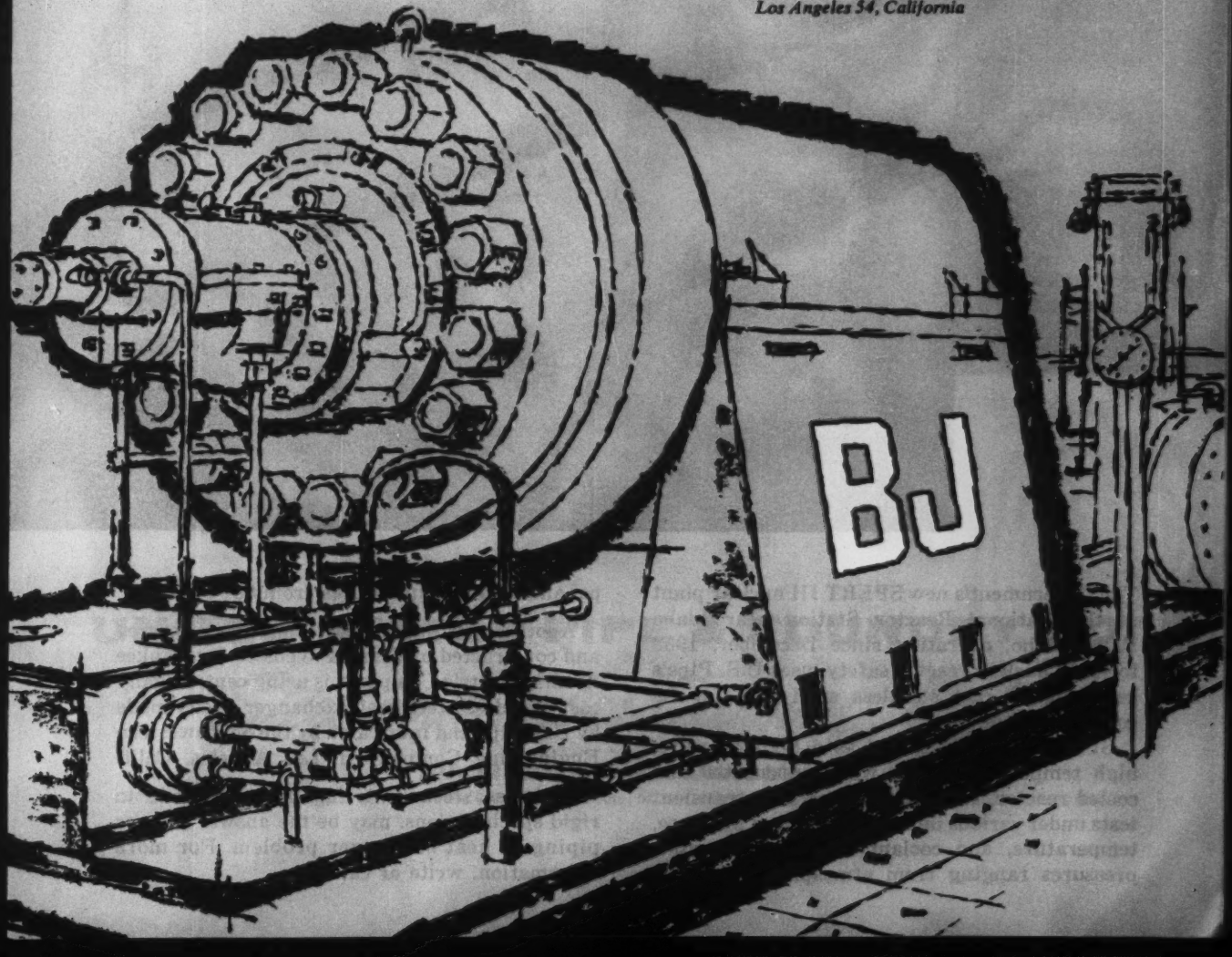
Reliability is the only real "bargain" you can afford in a boiler feed pump. Reliability that comes from the basic quality built into a pump, and the reliability that assures long, continuous performance under all conditions.

At BJ, quality is a full time job. Trained personnel with long experience in building quality pumps are combined with the latest facilities, equipment and special techniques. The result is a line of boiler feed pumps to meet the higher speeds and temperatures, greater capacities and higher pressures required of modern boiler feed service.

BJ Quality does cost less in the long run!

Baltimore Gas and Electric Company *adds four more BJ Double Case Boiler Feed Pumps to 22 already installed. One new 7200 HP unit will deliver 3035 GPM with 3290 PSI discharge pressure at 342°F.*

BYRON JACKSON PUMPS, INC.
SUBSIDIARY OF BORG-WARNER CORPORATION
P.O. Box 2017 A, Terminal Annex,
Los Angeles 54, California



new nuclear plants choose

FULFILLS THE EXACTING

HEAT EXCHANGERS

Centrifugal stainless steel castings readied for shipment by U.S. Pipe

The Government's new SPERT III nuclear plant at the National Reactor Station near Idaho Falls, Idaho, operating since December, 1958 to study nuclear reactor safety, uses U.S. Pipe's centrifugally cast stainless steel pipe for its coolant system.

SPERT III is classified as a high pressure, high temperature, light water moderated and cooled reactor. Its versatility permits transient tests under various initial conditions of pressure, temperature, and coolant flow. For example, pressures ranging from atmospheric to 2,500 psi and water temperatures from 68° to 668° F.

Another new nuclear power plant, engineered and constructed by Stone & Webster for Yankee Atomic Electric Company, is using centrifugally cast stainless steel heat exchanger shells made by U.S. Pipe and fabricated by the Southwestern Engineering Company in Los Angeles, Calif.

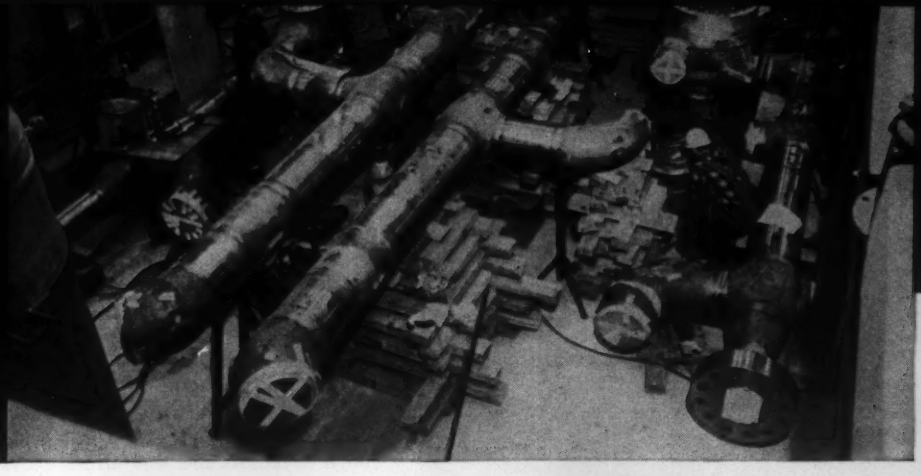
Stainless steel, centrifugally cast, made to rigid specifications, may be the answer to your piping or heat exchanger problem. For more information, write or call:

centrifugally cast stainless

REQUIREMENTS OF [illegible] AND COOLANT SYSTEMS

Shop-fabricated heat exchanger shells of centrifugal [illegible] ready for shipment to [illegible] Atomic Electric [illegible]

Subassemblies of primary coolant piping of centrifugal [illegible] steel being installed in [illegible].



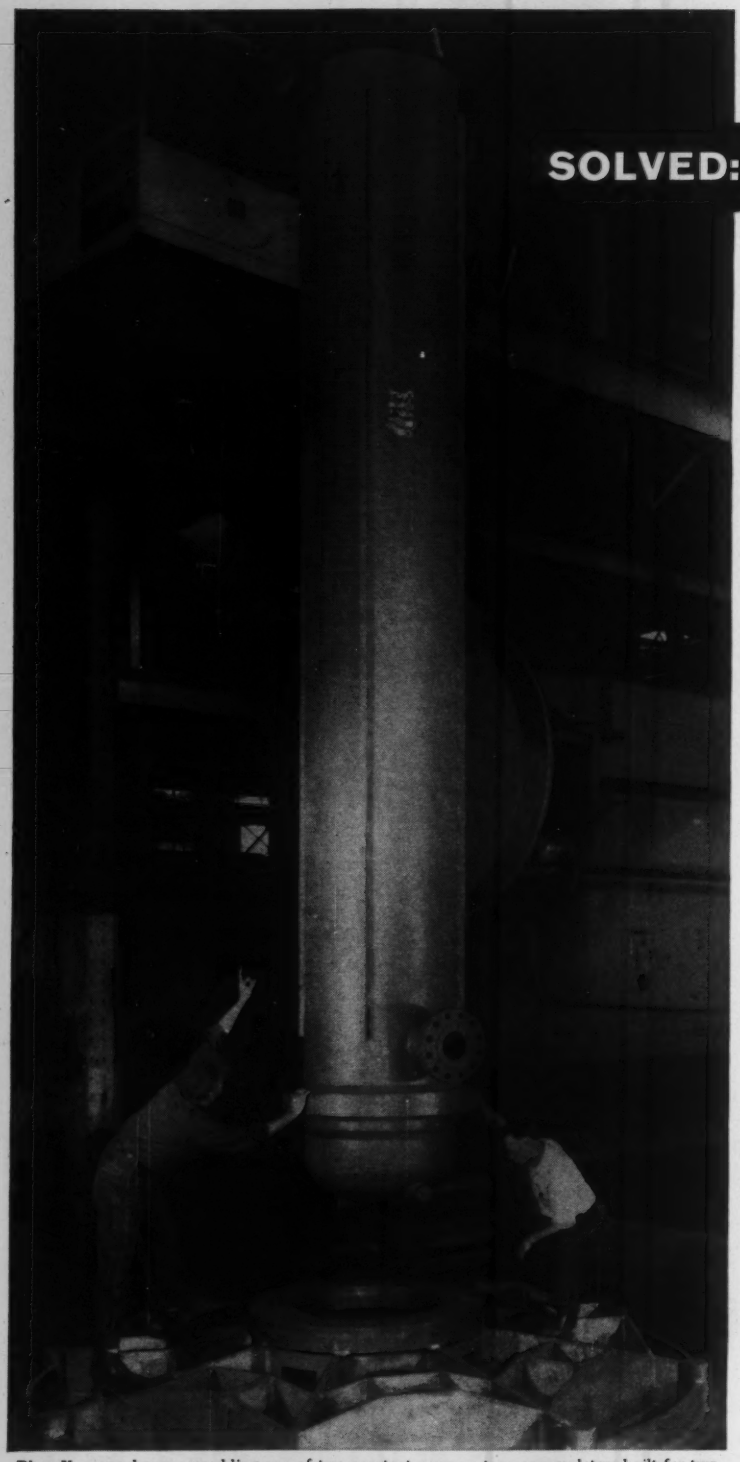
UNITED STATES PIPE & FOUNDRY CO.

Steel and Tubes Division

STEEL & TUBES DIVISION U.S. PIPE

BURLINGTON, NEW JERSEY

SALES OFFICES: BURLINGTON, BOSTON, BIRMINGHAM, CHICAGO, CLEVELAND, DALLAS, LOS ANGELES, NEW YORK, PITTSBURGH, SAN FRANCISCO



Blaw-Knox workmen assembling one of two constant pressure type accumulators built for two of America's largest steel mills. Sandusky supplied the straight cylindrical sections for both.

SOLVED: by Sandusky Centrifugal Casting

Blaw-Knox chooses 10-ton SANDUSKY CASTING for giant slabbing mill

When an 18¼-foot cylinder was needed for a new giant Universal slabbing mill built by Blaw-Knox Company's East Chicago (Indiana) Works for a well known steel mill, they found that the most practical and economical way to meet all requirements was with a Sandusky Centrifugal Casting.

This 10-ton carbon steel cylinder, 32" O.D. with a 3½" wall, functions as an accumulator in the mill's hydraulic roll balancing system. Essentially a pressure vessel, it simultaneously supports the ram and ballast weighing 226 tons—the weight required to develop constant operating pressure of 1000 p.s.i.

"Only a dimensionally stable, one-piece cylinder could perform satisfactorily in this service," a Blaw-Knox official asserted. *"Distortion could lead to binding, loss of pressure and costly downtime. Sandusky's ability to produce this heavy walled cylinder in one 18¼ foot length met all our requirements of cost, stability, and strength."*

Sandusky cylinders up to 33 feet long —from 7" to 54" O.D.— and in a wide range of ferrous and non-ferrous alloys —may well be the answer to *your cylindrical problems,* too.

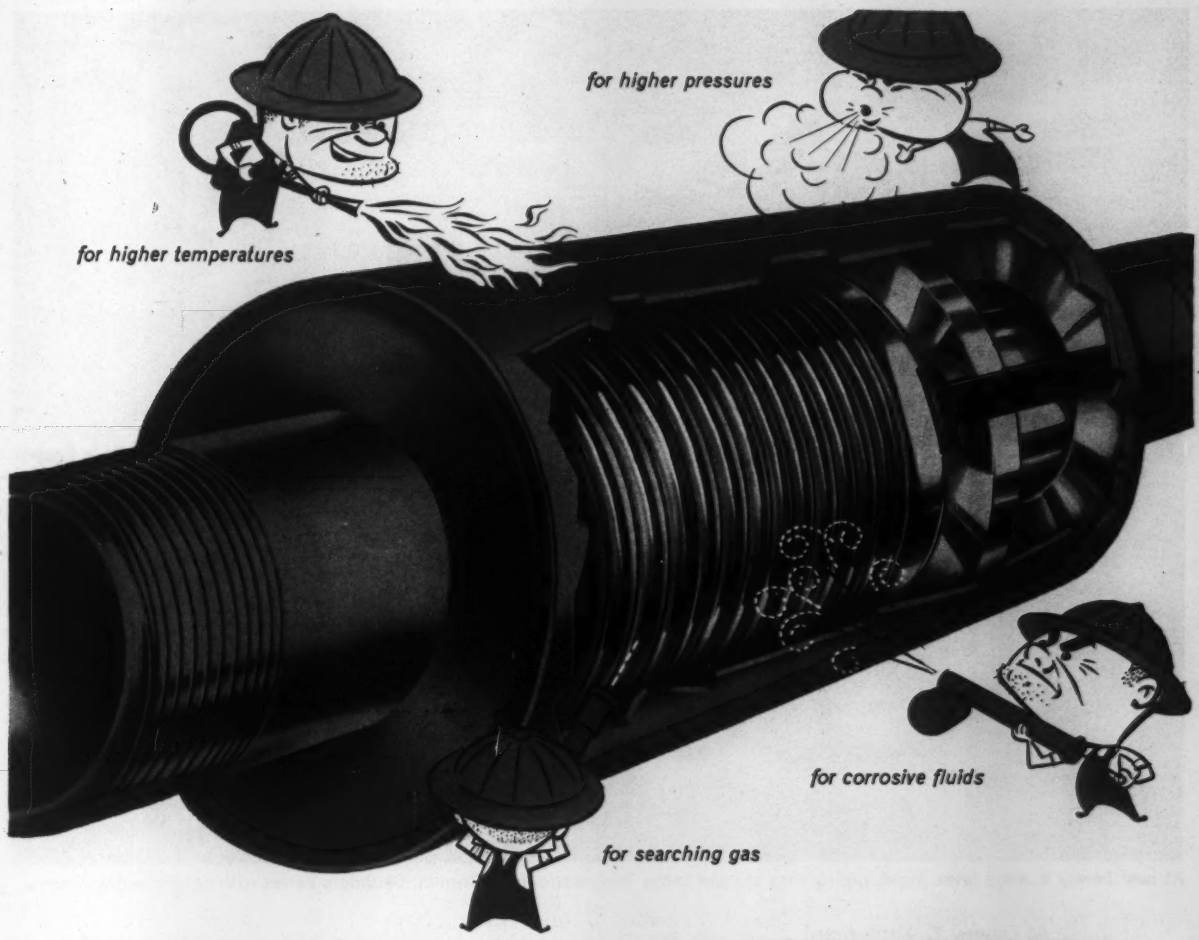
Write to us at Sandusky, Ohio. Ask for latest Bulletin #200.

SANDUSKY ® **CENTRIFUGAL CASTINGS**

FOUNDRY & MACHINE CO.

SANDUSKY, OHIO—Stainless, Carbon, Low-Alloy Steels—Full Range Copper-Base, Nickel-Base Alloys

6303



FLEXONICS MODEL HS EXPANSION COMPENSATOR NOW IN STAINLESS STEEL FROM TIP TO TIP!

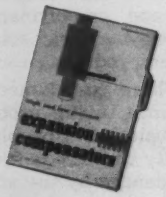
Another important *first* from Flexonics! The original high-pressure, heavy-duty Expansion Compensator is now available entirely of stainless steel—to handle pipe expansion under conditions of higher pressure, higher temperature, corrosive fluids, chemicals and gases.

Screwed, welding, or flanged ends; heavy-duty two-ply Flexonics bellows; positive anti-torque design; and protective shroud . . . all are of stainless steel, to absorb up to 2″ pipe expansion under corrosive conditions, at working pressures up to 175 p.s.i., temperatures up to 750°F. Pipe sizes ¾″ to 3″.

Inch for inch, this is your simplest, lowest-cost way to take up pipe motion under difficult operating conditions. Completely packless, it never needs maintenance. Designed to outlast the piping system you install it in. Also Model H—carbon steel construction with stainless steel bellows; and Model HB—all bronze.

Make Flexonics Expansion Compensators a cost-cutting part of your next piping job.

Write for informative and helpful Engineering Guide No. 222-B



EC-140

Flexonics
corporation

In Canada: Flexonics Corporation of Canada, Ltd., Brampton, Ont.

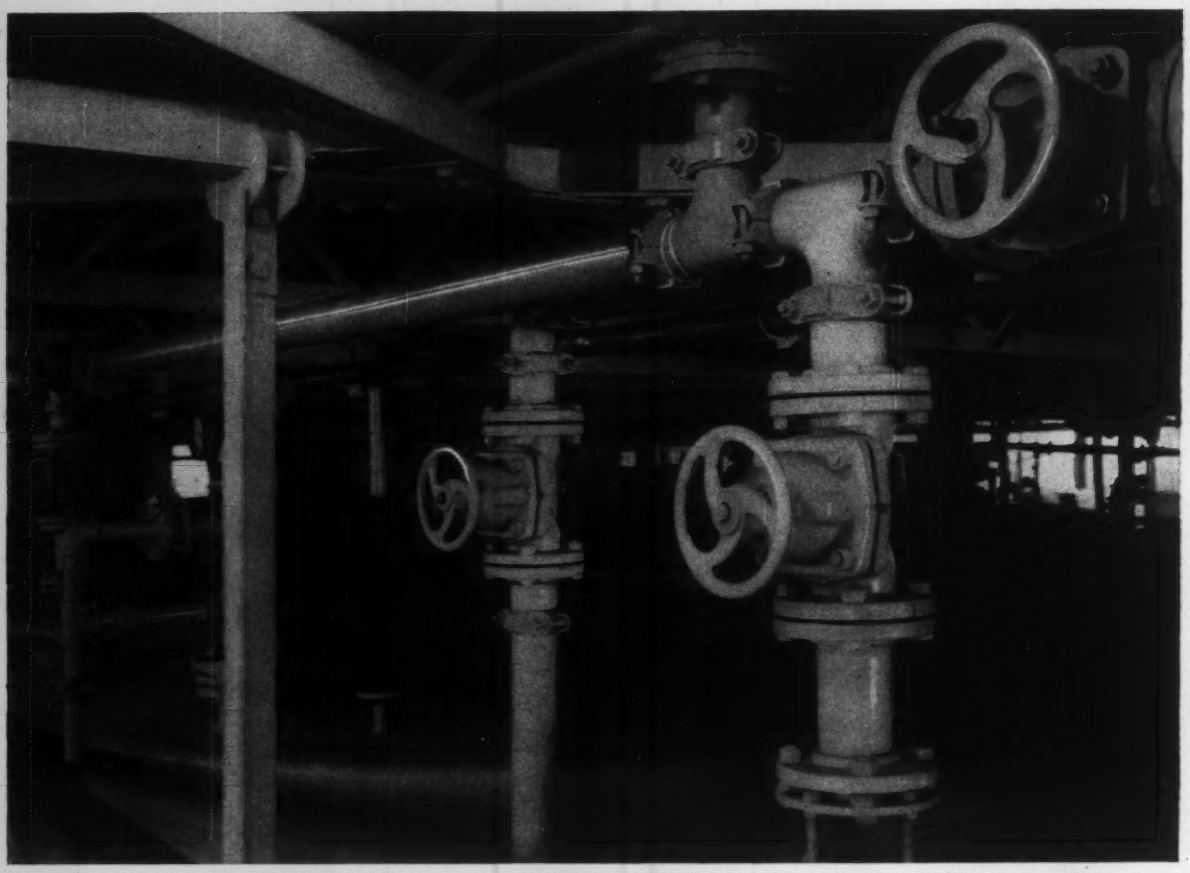
EXPANSION JOINTS | METAL HOSE | SYNTHETIC HOSE | BELLOWS | AERO/SPACE COMPONENTS

SUBSIDIARY OF CALUMET & HECLA, INC.

ATTACH TO YOUR LETTERHEAD—MAIL TODAY!

FLEXONICS CORPORATION
1305 S. Third Avenue
Maywood, Illinois

Please send me my personal copy of Flexonics Engineering Guide No. 222-B, including full information on using Flexonics Expansion Compensators to absorb pipe movement.



At new Dewey & Almy latex plant, piping into storage tanks has plastic-lined Grinnell-Saunders Valves with neoprene diaphragms.

At Dewey & Almy plant...

Grinnell-Saunders Diaphragm Valves guard against plugging, corrosion, contamination

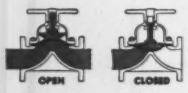
The new Owensboro, Kentucky plant of Dewey and Almy Chemical Division, W. R. Grace & Co., makes polyvinyl acetate emulsions and butadiene-styrene co-polymers for adhesives, paper coatings, emulsion paints and other products.

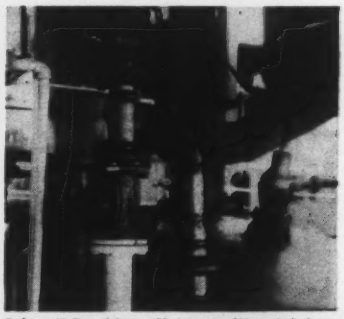
These co-polymers present several manufacturing problems: build-up of obstructions that plug lines, high viscosity that needs wide-open lines, easy hardening by the air.

Selected to handle this tough job: *Grinnell-Saunders Diaphragm Valves.* These rugged valves have a diaphragm that lifts high for streamline flow; seals tight for positive closure. Bonnet mechanism is completely isolated from material in the line by the diaphragm to prevent corrosion and contamination.

What's more, Grinnell-Saunders Diaphragm Valves give smooth passage of material . . . eliminate trapping of solids, reduce frictional resistance. You can choose from a number of body, lining and diaphragm materials.

Find out how Grinnell-Saunders Diaphragm Valves can help *your* installation. Write Grinnell Company, Providence 1, R. I.





Grinnell-Saunders Valves with stainless steel bodies and teflon diaphragms were specified for the reflux lines of this co-polymer reactor.

GRINNELL-SAUNDERS DIAPHRAGM VALVES

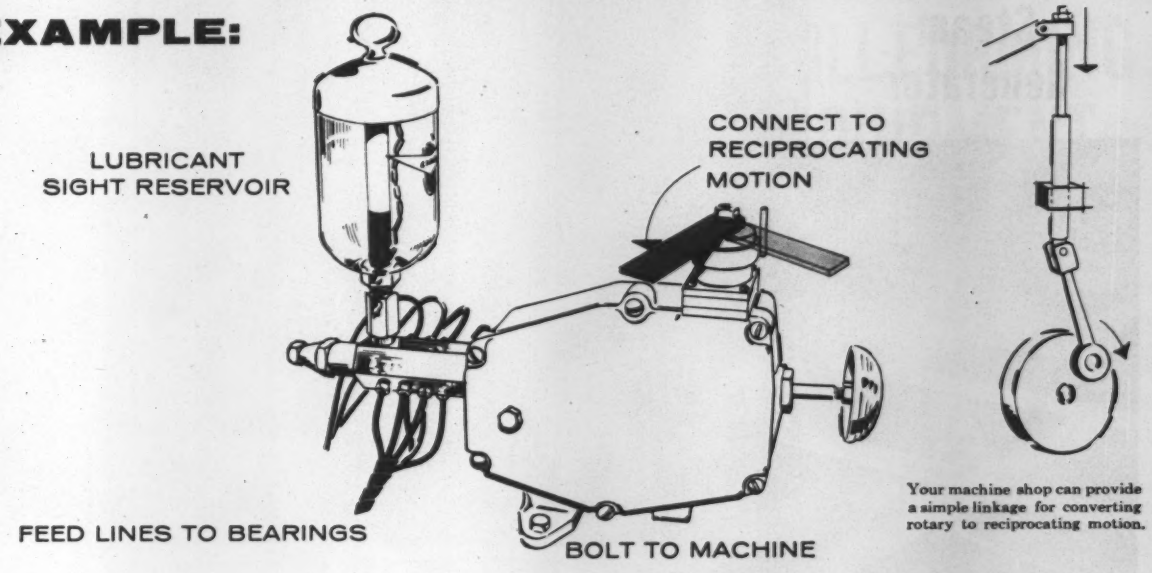
GRINNELL COMPANY, PROVIDENCE 1, R. I. • BRANCH WAREHOUSES AND DISTRIBUTORS FROM COAST TO COAST
PIPE FITTINGS • VALVES • PIPE HANGERS • PREFABRICATED PIPING • UNIT HEATERS • PIPING SPECIALTIES

DESIGN TIPS...on automatic lubrication

PROBLEM: Lubricate machine tool automatically without using electricity or compressed air

SOLUTION: Harness reciprocating or rotary motion for positive displacement lubrication with Lincoln's ratchet Multi-Luber*

EXAMPLE:



Your machine shop can provide a simple linkage for converting rotary to reciprocating motion.

You can harness reciprocating or rotary motion on your light machine tools to provide power for automatic lubrication with Lincoln's new ratchet-operated Multi-Luber. As little as .52" straight-line motion will drive the worm gear that cycles lubricant through the Multi-Luber outlet ports to bearings.

Three operating ratios of worm gear reduction (100:1, 50:1, and 25:1) are available to satisfy requirements for any application. With standard setting, the Multi-Luber discharges 0.0025 ounces of lubricant from each port every time it cycles. Output of the first four ports can be doubled.

The ratchet Multi-Luber can overcome 2000 psi back pressure while operating. It handles light grease as well as oil and delivers an accurately-measured, predetermined amount of lubricant to individual bearings. One ratchet Multi-Luber will feed from seven to 12 lubrication points. For more than 12 points, you can use additional Multi-Luber units.

Simple to hook up, the ratchet Multi-Luber is the most versatile lubrication device available. For instance, two ratchet Multi-Luber units could be mounted on a 15-bearing machine—one to dispense grease and the other oil. Install it in any position convenient for linking the drive arm to a consistently moving part.

NOTE TO MANUFACTURERS:
Lincoln assists manufacturers in adapting automatic lubrication to either new or in-plant machines. For OEM production, contact Lincoln's Original Equipment Sales Division. For in-plant applications, contact the Industrial Sales Division.

Trade Mark Registered

LINCOLN ENGINEERING CO. Original Equipment Sales Division
5703-38 Natural Bridge St. Louis 20, Mo.

- ☐ Please send me operating data sheets on the ratchet Multi-Luber.
- ☐ Please send Catalog 50 (Multi-Luber).
- ☐ Please send Catalog 81 (Industrial Power Lubrication Systems).
- ☐ Have your representative call to advise me regarding adaptation of the Multi-Luber to my machine.

NAME_____ TITLE_____

COMPANY_____

ADDRESS_____

CITY_____ ZONE____ STATE_____

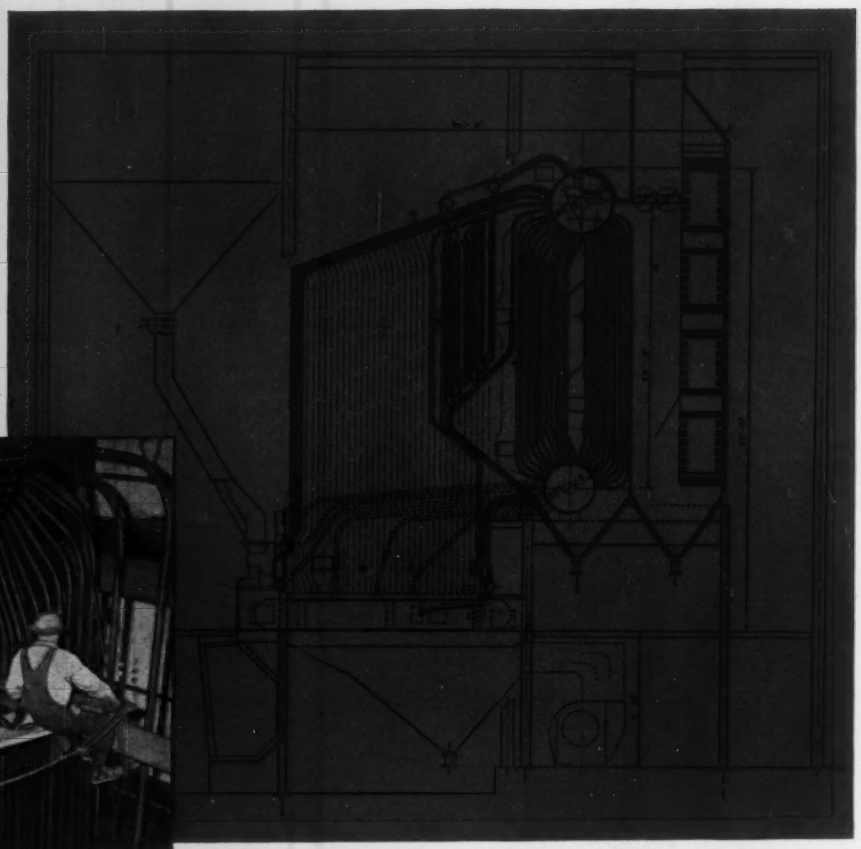
1063

LINCOLN
ST LOUIS

LINCOLN
ENGINEERING COMPANY

ST. LOUIS 20, MO. • DIVISION OF THE McNEIL MACHINE & ENGINEERING CO.

Union Starch Installs a Modern Coal Fired Steam Generator



Longitudinal section through unit.

Tubes being installed in steam and water drums.

PROJECT BY
ROGERS SCHMIDT
ENGINEERING CO.
ST. LOUIS, MO.

This 125,000 pounds per hour capacity Vogt Steam Generator, especially designed to burn bituminous coal, serves the Granite City, Illinois plant of the Union Starch and Refining Company. The unit operates at 475 lbs. pressure and delivers steam at 750°F. total temperature. It has water cooled front, sides and roof of furnace and employs a spreader type coal stoker.

Vogt offers a complete line of custom built and package type steam generators for power, processing and heating. Bulletins are available upon request.

For Custom Installation Bulletin VF-VS-2 • Package Unit Bulletin PSG-3, address Dept. 24A-BM.

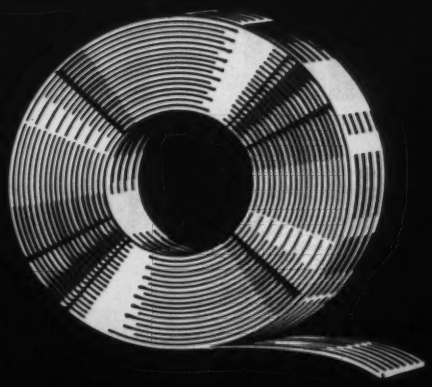
HENRY VOGT MACHINE CO.
P.O. BOX 1918, LOUISVILLE 1, KENTUCKY
SALES OFFICES: New York, Chicago, Cleveland, Dallas, Camden, N. J., Los Angeles, St. Louis, Charleston, W. Va.

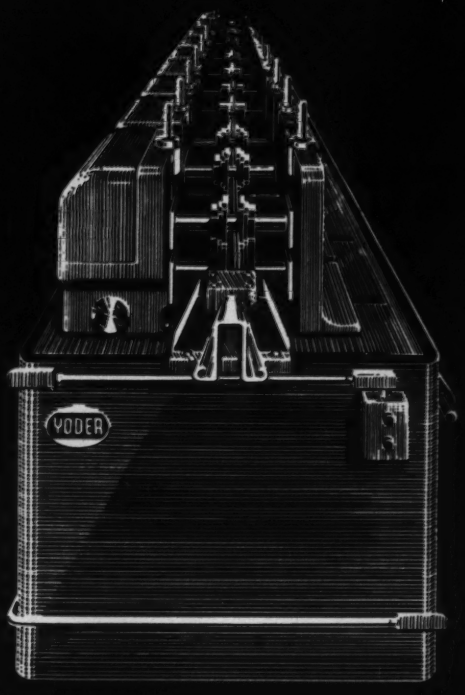
For Direct Long Distance to Louisville Dial: 502 ME 4-9411

Vogt

STEAM GENERATORS

. . . from start





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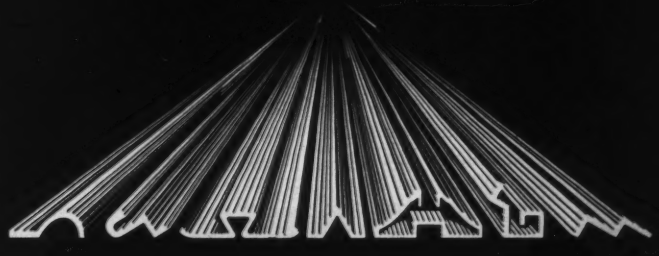


COLD ROLL-FORMING EQUIPMENT

PIPE AND TUBE MILLS (ferrous or non-ferrous)
ROTARY SLITTING LINES

YODER ROLL-FORMING EQUIPMENT

Profits are available to you through the production of many shapes in metal... made with precision and economy on Yoder Cold Roll Forming Equipment.

Produce tubular, ornamental or structural shapes from a variety of metals in widths from a fraction of an inch up to 80 inches or more, and in stock up to ¾" thick. Your investment is comparatively modest, and with proven low operating costs, will give you one of the most profitable operations in your plant.

Experienced Yoder engineers will, without obligation, study your annual metal forming requirements. Many times they can point out that the installation of roll forming equipment would—even if operated only intermittently—soon justify its initial cost.

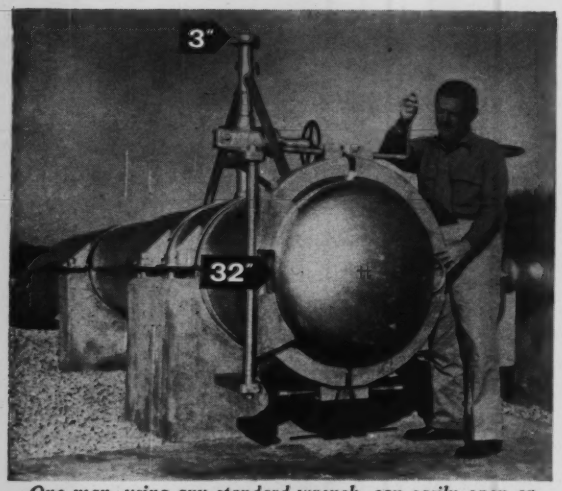
Send today for this comprehensive, 88-page illustrated text. It fully describes Cold Roll Forming Equipment, processes and products.

THE YODER COMPANY
5499 Walworth Ave. • Cleveland 2, Ohio

ENGINEERING
YODER
MANUFACTURING

NEW...FROM TUBE

an improved hinged closure for pipe lines, piping and process equipment



One man, using any standard wrench, can easily open or close the TUBE-TURN *Hinged Closure. Has important safety features, too!*

For vertical applications, TUBE-TURN *Hinged Closures can be equipped with spring-loaded, counterbalanced caps.*

Tube Turns announces a new line of hinged closures with important advantages for pipe lines, piping and process equipment wherever frequent access is required or where the use of blind flanges would be cumbersome and time consuming. Proved in scores of applications by major companies, the unique TUBE-TURN* Hinged Closure provides these benefits:

Saves installation time. Light weight assembly easier to handle. Completely fabricated . . . ready to install. Requires only one butt-weld to join to pipe, tank or vessel opening.

Saves operating cost. One man, using a standard wrench, can easily open or close the largest size closure in a few minutes. No threads or lugs to engage or flanges to line up. No parts to fail. No hammering or tugging. Can be adapted to motorized operation. Closures for vertical applications can have counterbalanced caps for easy operation.

Saves on maintenance. Oil resistant, self-energizing static "O" ring provides seal. Does not move when cover is opened or closed. No rubbing or chafing to shorten seal life.

Built-in safety. Exclusive design features of two-piece yoke, double-ended right- and left-hand threaded bolts and hinged cap guard against accidental opening under pressure.

These new TUBE-TURN Hinged Closures provide still another *plus value* you can get when you specify TUBE-TURN products and buy them from your nearby Tube Turns' Distributor. They are available in sizes 2" through 42" for A.S.A. 150-lb, 300-lb and 600-lb service . . . in steel or alloys.

*"TUBE-TURN" and "⊛" are trademarks of Tube Turns.

TURNS...

FREE BULLETIN . . . Complete information on the new line of TUBE-TURN Hinged Closures will be sent on request. Mail coupon.

TUBE TURNS, Dept. ME-10
224 E. Broadway • Louisville 1, Kentucky

Please send Bulletin TT956 on new TUBE-TURN Hinged Closures.

Company Name _____

Company Address _____

City _____ *Zone* ____ *State* _____

Your Name _____

Position _____

Another tt *plus value from...*

TUBE TURNS

DIVISION OF CHEMETRON CORPORATION
Louisville 1, Kentucky

DISTRICT OFFICES: Atlanta • Buffalo • Chicago • Columbus • Dallas Denver • Detroit • Houston • Kansas City • Los Angeles • New York Philadelphia • Pittsburgh • Richmond • St. Petersburg • San Francisco • Seattle Shreveport • Tulsa
In Canada: TUBE TURNS OF CANADA LIMITED, Ridgetown, Ontario
District Offices: Edmonton • Montreal • Toronto
In Mexico: TUBE TURNS DE MEXICO, Mexico City

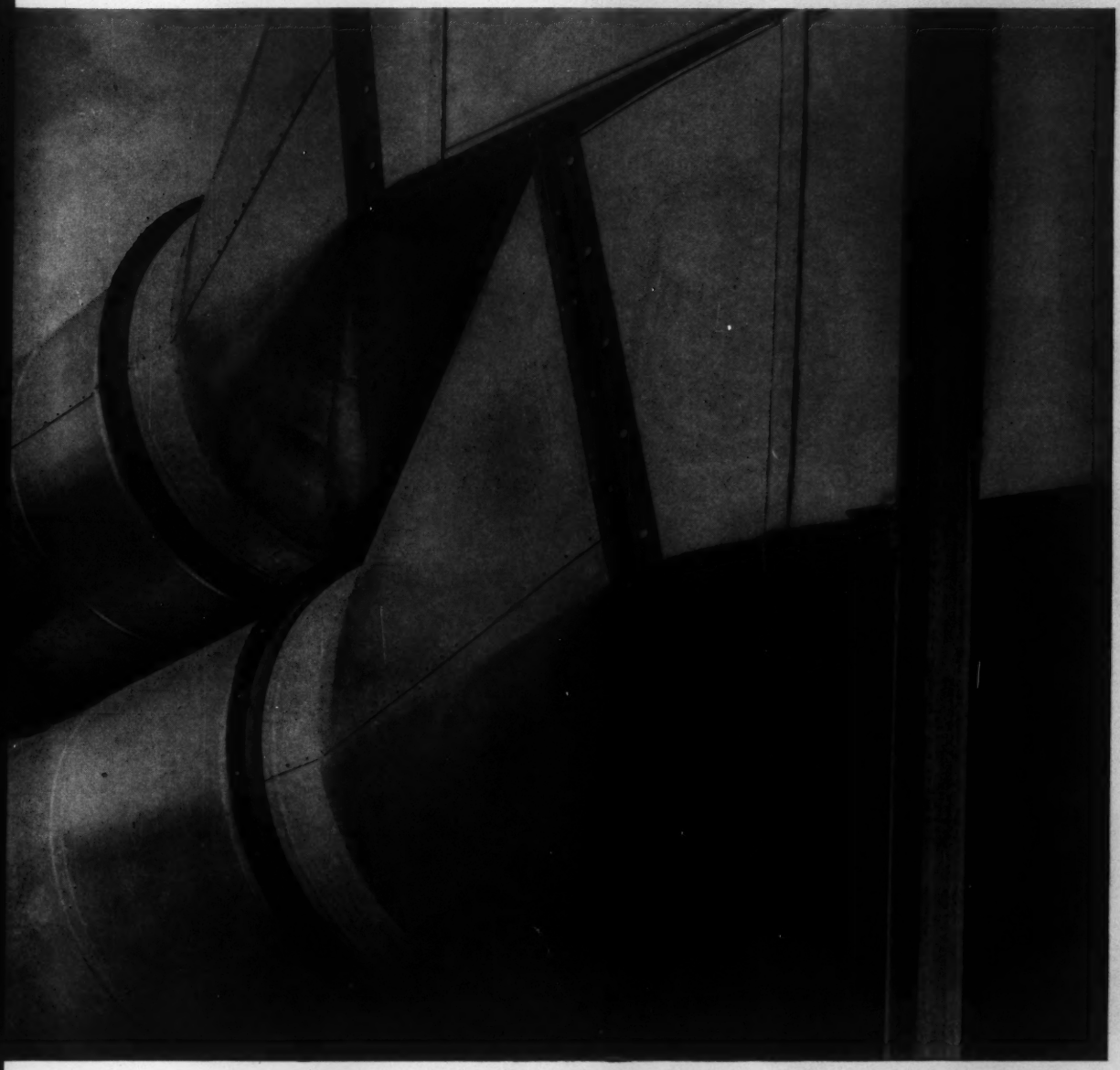
Operation: Dust Control

(One of a series)

At National Cash Register, 10 tons of wood

Dust is trapped at the source by hoods engineered for the individual job . . .

. . . and is piped from 160 locations to five giant Pangborn Cloth Bag Collectors.



shavings, chips and dust are collected daily!

Mammoth is the word for the 5-floor woodworking plant of National Cash Register headquarters, Dayton, Ohio. Processing nearly 300,000 sq. ft. of lumber each month, this operation generates 10 tons of waste material per day.

To protect NCR employees, equipment, plant and neighborhood, five Pangborn Cloth Bag Dust Collectors trap 90 cu. ft. of fine dust for disposal and, during the winter months, permit recirculating of the already-heated, cleaned air. This efficient performance of Pangborn Dust Control saves thousands of dollars in heating costs during the cold weather. In addition, a neighborhood and health nuisance has been eliminated; equipment maintenance and plant housekeeping costs have been minimized.

Dust a continuing problem in *your* plant? Talk to the Pangborn man in your area or write: PANGBORN CORPORATION, 2200 Pangborn Blvd., Hagerstown, Md. *Manufacturers of Dust Control, Blast Cleaning, Vibratory Equipment—Rotoblast® Steel Shot and Grit.®*

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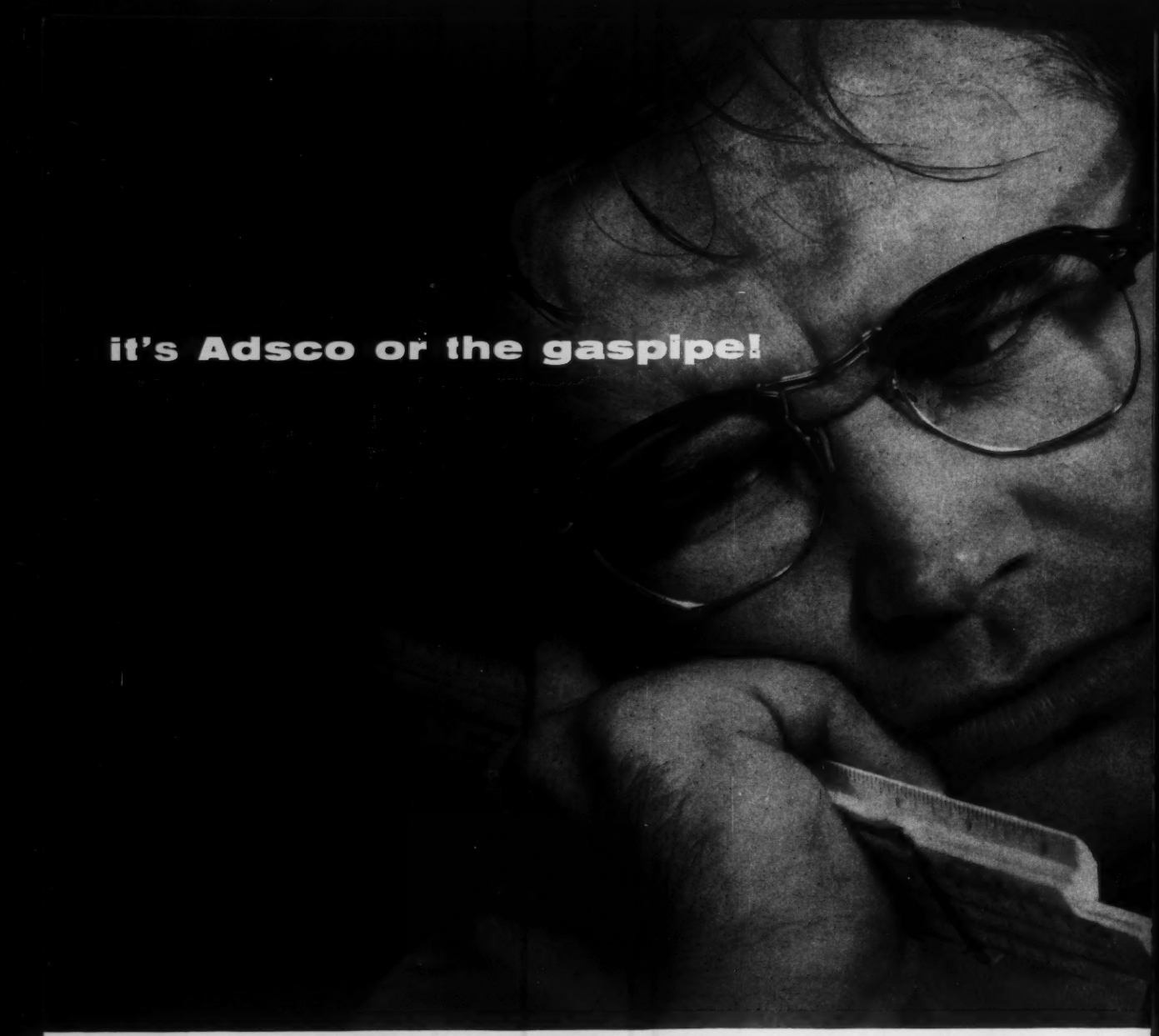

ONLY ADSCO HAS ALL 3 TYPES OF EXPANSION JOINTS

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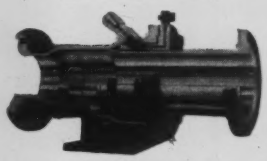
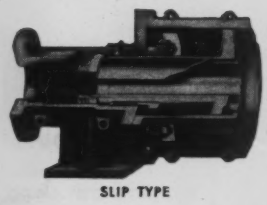


RAM-PAK



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Choose Adsco, by all means. An Adsco man is no farther away than your telephone. He's a calm, cool and collected fellow who can straighten out any expansion problem in your piping system. He loves to be asked . . . call him quick, man, before it's too late!

Write for comprehensive catalogs

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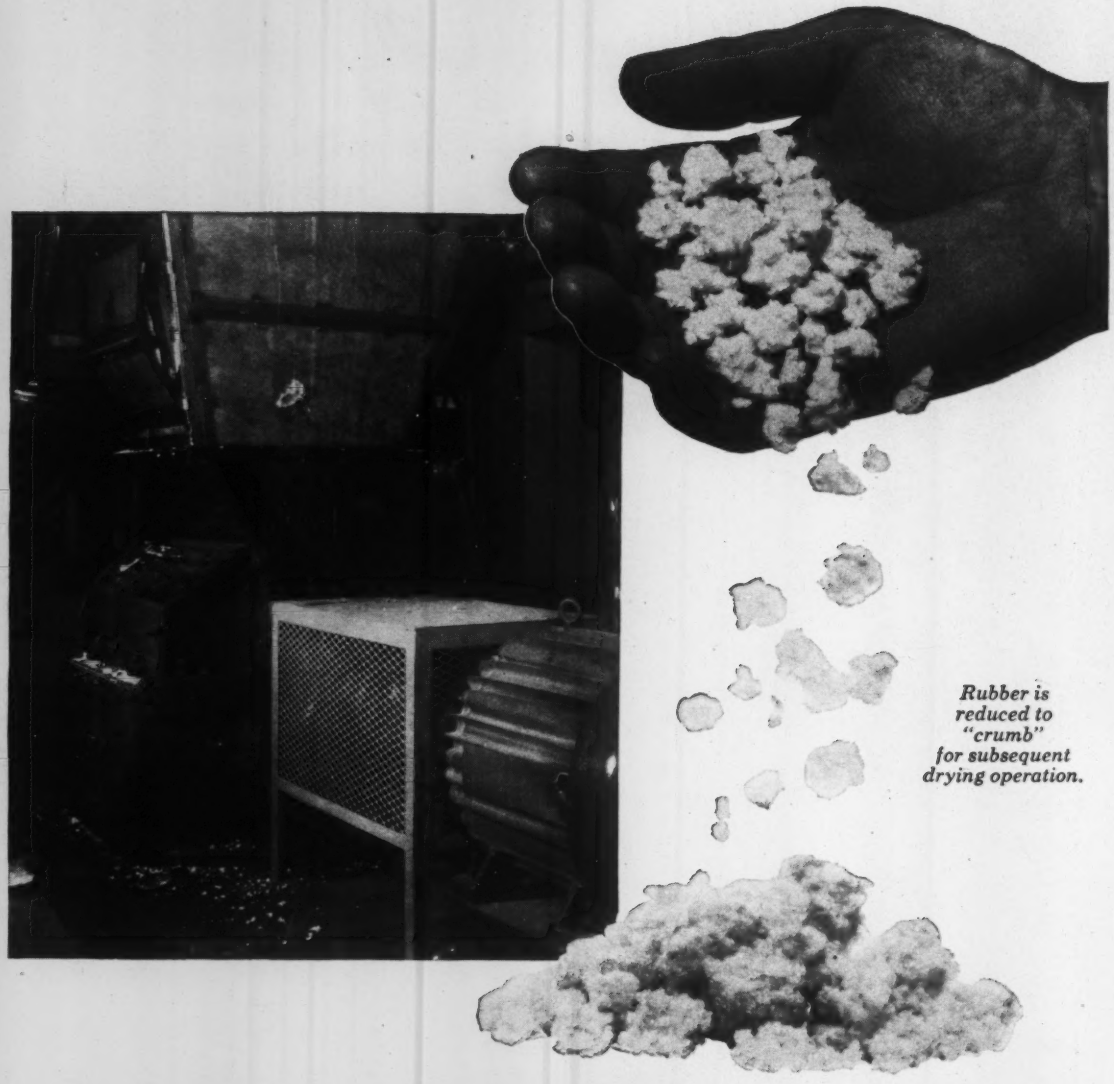

Rubber is reduced to "crumb" for subsequent drying operation.

JEFFREY DISINTEGRATORS

save time in processing rubber

Jeffrey disintegrators quickly rip and tear slabs of wet synthetic rubber into small sized chunks for efficient drying and melting.

The disintegrators shred rubber slabs to "crumb" size of minus 2″ to plus ¼″ in one operation. These Jeffrey units have an excellent service record with low maintenance demands.

Jeffrey machines can reduce a wide range of materials, whether soft or hard, to the size you want. The Jeffrey Manufacturing Company, 915 North Fourth Street, Columbus 16, Ohio.

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BONUS LIFE

BONUS PROTECTION

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TITUSVILLE WTP

FROM THE BOILER CAPITAL OF THE WORLD

• BONUS LIFE means longer life and less refractory maintenance made possible by Titusville's unique WTP design featuring *65% Black Surface Tube Area coverage on rear wall.*

Titusville's increased black surface tube area means less refractory maintenance through longer refractory life (less down-time for replacement) and a faster steamer.

• BONUS PROTECTION provided by Titusville WTP's *double casing design* solves the corrosive product problem.

Most water tube steam generators operate intermittently. When dew point is approached at low fire condition, corrosive product can form quickly in single casing boilers.

Titusville WTP's double casing design (with insulation between) reduces temperature differential. Result: formation of corrosive product almost entirely eliminated for many times more casing life.

THE TITUSVILLE IRON WORKS COMPANY

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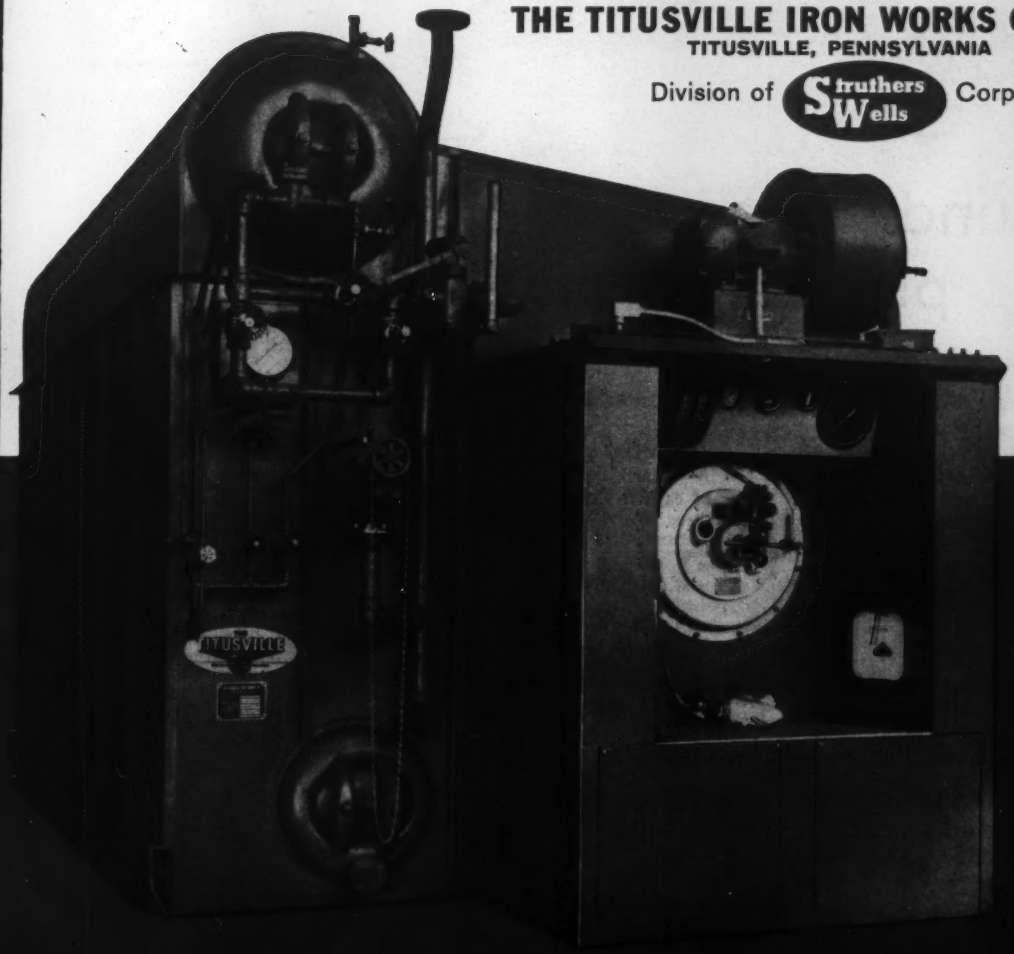
Division of Struthers Wells Corporation



For your
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specify
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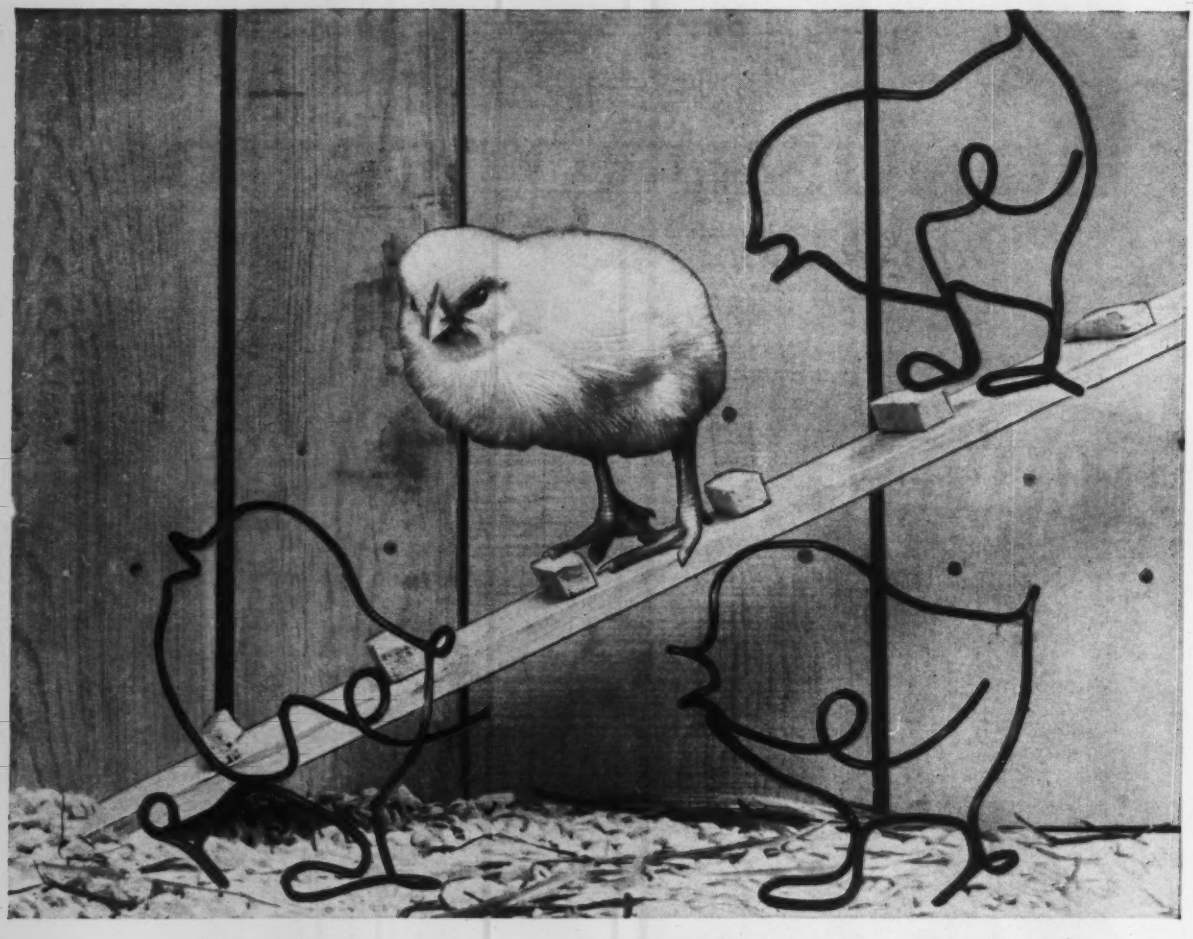


Bundy can mass-fabricate practically anything

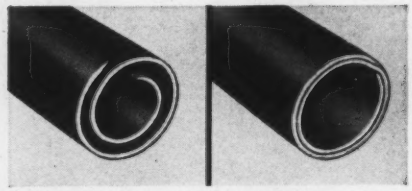
Bundyweld®—the original double-walled steel tubing—is ideal for everything from simple bends to complex shapes

The old adage, "Don't count your chickens before they hatch," is a good one . . . but it rarely applies to Bundy. That's because, no matter how complex your tubing problem, you *can* count on Bundy for the perfect solution.

Bundy engineers and designers are backed by years of experience in the mass-fabrication of steel tubing. And they are available to you at any stage of product development for time- and money-saving suggestions. Their key: Bundyweld®!

Bundyweld steel tubing is double-walled, copper-brazed, stronger, with higher bursting and fatigue strengths. That makes Bundyweld the safety standard in small-diameter tubing—and a wise choice for a wide variety of tubing applications! Meets ASTM-254 and Government Spec. MIL-T-3520, Type III.

So, when you want to talk tubing, talk to the leader—Bundy! Phone, write, or wire Bundy Tubing Company, Detroit 14, Michigan.



Bundyweld is the original tubing double-walled from a single copper-plated *steel* strip, metallurgically bonded through 360° of wall contact for amazing strength, versatility.

Bundyweld is lightweight, uniformly smooth, easily fabricated. It's remarkably resistant to vibration fatigue; has unusually high bursting strength. Sizes up to ⅝" O.D.

There's no substitute for the original Bundyweld Tubing.

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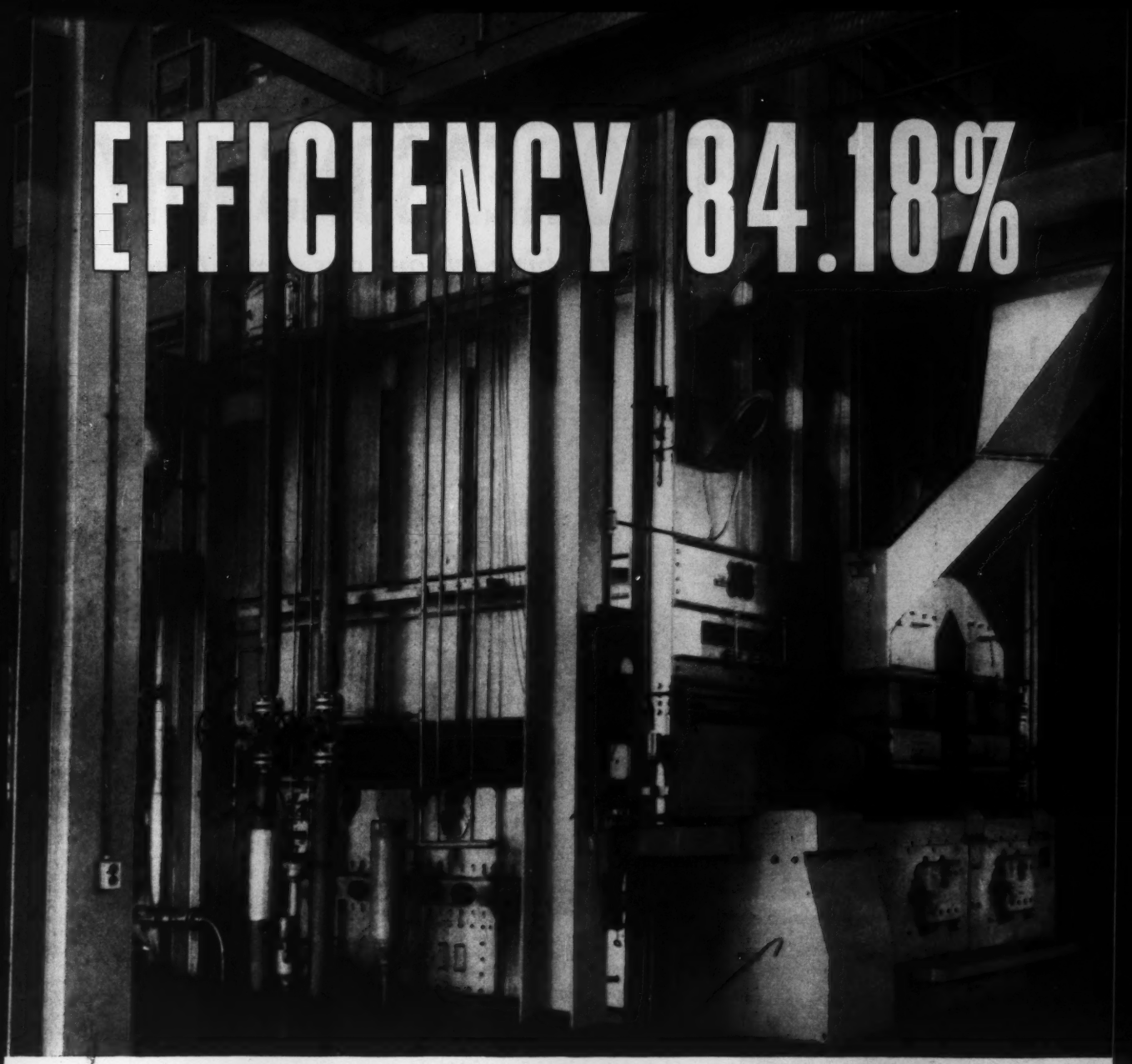
WORLD'S LARGEST PRODUCER OF SMALL DIAMETER TUBING. AFFILIATED PLANTS IN AUSTRALIA, BRAZIL, ENGLAND, FRANCE, GERMANY, ITALY, JAPAN

EFFICIENCY 84.18%



Wiley & Wilson, Consulting Engineers
J. L. Hamilton Engineering Co., Installing Contractor

JOB: Supplying steam for space heat, hot water service, hospital needs, and refrigeration at Univ. of Virginia. Campus includes 100 buildings (approx.) plus 600-bed hospital.

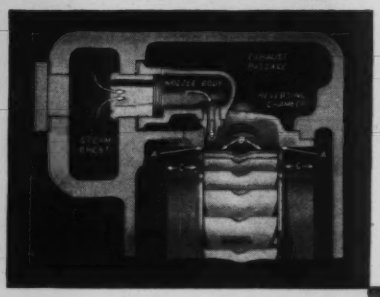
STEAM GENERATORS: Two from Union carry the entire load. Recently installed, the one above is a Type VO two-drum unit (72,000 lbs./hr. continuous, 475 psi). Spreader stoker fired. Air heater supplied for heat recovery.

PERFORMANCE: One month's operating log for illustrated unit shows: 33,539,300 lbs. of steam generated. 1,382.5 tons of 14,243 BTU coal consumed. Average evaporation of 12.1 lbs. Max. 8-hr. load of 65,000 lbs. Max. 24-hr. load of 59,000 lbs. *Average efficiency for month — 84.18%.*

MORE FACTS: Many types and sizes of Union Steam Generators are covered in illustrated Bulletin GB-959. Write: Union Iron Works, Erie, Pa.

UNION

steam generators



TWO REASONS WHY

this turbine seldom sees down time

1 ***Generous wheel clearances:*** AA —rim clearance, B—blade clearance, CC —side clearance. Blades can't foul as they are protected by rims. Rubbing at AA will do no damage. Side clearance is so large (about one inch) that end-play from excessive external thrust cannot damage wheel.

2 ***Blade wear is of little consequence.*** In a Terry solid-wheel turbine, the steam enters the buckets at right angles to the shaft. As its power-producing action takes place on the curved surfaces at the backs of the buckets, wear does not materially affect horsepower or efficiency.

To prevent costly shutdowns for repairs, Terry builds bonus reliability into each solid-wheel turbine. Two of the ways in which this is accomplished are shown in the diagrams at the left.

Further details of these simple, fool-proof turbines are illustrated and described in bulletin S-116. If you do not already have a copy of this publication, send for one today. No cost or obligation.

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TERRY

How Much Steam Should a Steam Trap Trap?

. . . some answers to commonly asked questions about the primary job of a steam trap

You don't need a doctor's degree in thermodynamics to answer the question at the top of this page. Naturally, a steam trap should trap *all* the steam.

Unfortunately for you, the problem isn't quite that simple. After all, a shut off valve would trap all the steam . . . and condensate, and air, and carbon dioxide as well.

So we'd better amend the answer to the question this way: A steam trap should trap *all* the steam but *must* remove condensate, air and carbon dioxide as rapidly as they accumulate.

With this established, let's take a closer look at what's involved:

A Steam Trap Should Trap All The Steam

If you've had experience with several different makes of traps, you already know that some trap steam better than others. The operating principle of the trap is what makes the difference. We like to talk about it because Armstrong traps are designed so that no steam can get to the orifice. The valve is always water sealed. Result: *More efficient steam utilization, lower fuel costs.*

A Steam Trap Should Remove Condensate

All traps remove condensate—after a fashion. For maximum efficiency in the unit being drained, though, the trick is to get it out without waiting for it to cool and without leaking steam.

Armstrong's water sealed valve takes care of steam leakage. The inverted bucket operating principle opens the trap for water regardless of its temperature. This means you get the condensate out as quickly as it accumulates. Result: *Higher temperatures and better heat transfer in steam heated units.*

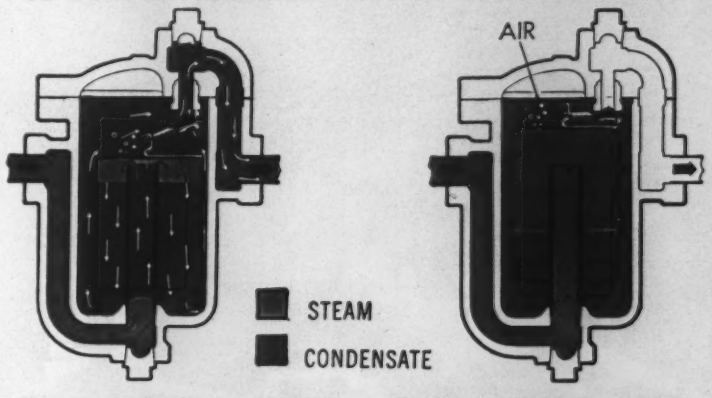
A Steam Trap Should Remove Air and CO_2

Part and parcel of the condensate removal problem is removal of air as well as oxygen and carbon dioxide—two real troublemakers. Air tends to reduce operating temperatures and interfere with heat transfer. CO_2 goes into solution to form corrosive carbonic acid which, for example, can eat unit heater tubes. O_2 aggravates the situation. Believe it or not, but all traps don't properly remove air and CO_2.

By now, you've probably guessed that Armstrong traps *do* remove air and CO_2. Armstrong design (see illustration) provides continuous venting of air and CO_2. By opening suddenly, the Armstrong trap creates a momentary pressure drop to "pump" the air down to be vented. Result: *Higher temperatures, faster heat-up, better heat transfer and reduced corrosion.*

Note: When required, specially sized air vents are furnished. For fast heat-up of low pressure on-and-off units, Armstrong provides open float and thermostatic air vent traps.

HERE'S THE STEAM TRAP DESIGN THAT GETS RID OF CONDENSATE AND AIR WITHOUT STEAM LOSS



Trap open. Condensate entering trap has caused bucket to lose buoyancy. Weight of bucket times leverage pulls valve open. Air is discharged along with condensate.

Trap closed. Steam has floated inverted bucket; valve is held tightly closed by system pressure. Air entering trap passes through bucket vent and accumulates at top of trap.

What's the Final Answer?

Summing it all up, you'll get the best service from steam heated units that are equipped with traps designed to trap *all* the steam and remove air and condensate as quickly as it accumulates. In our prejudiced viewpoint, this means Armstrong traps. More important are the several thousand users of Armstrong traps who have proved the point.

Before you make up your mind, though, consider the minimum maintenance requirements of Armstrong traps . . . and the convenient assistance your local Armstrong Representative provides. These are important plus values.

Put Up or Shut Up

We're so confident that we "put up". Armstrong traps are unconditionally guaranteed to satisfy. So you can find out for yourself with practically no risk. If you're not completely satisfied with the way they do their job, you can get your money back.

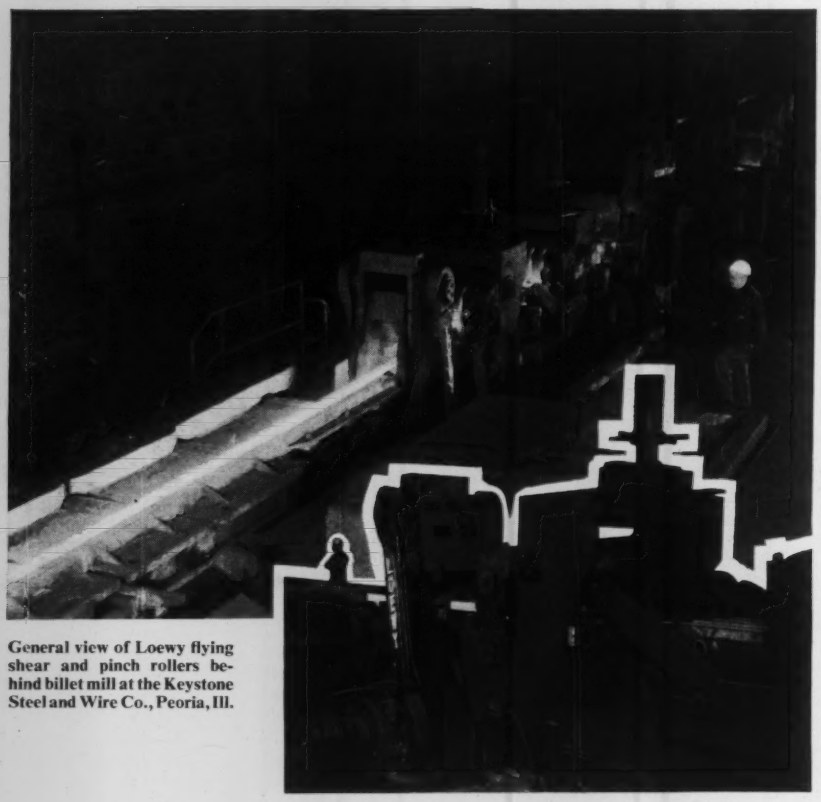
* * *

The 44-page Armstrong Steam Trap book goes into greater detail on these and other Armstrong features. It also discusses trap selection, installation and maintenance. Ask your Armstrong Representative for a copy or write

Armstrong Machine Works
8945 Maple St.
Three Rivers, Michigan

ARMSTRONG STEAM TRAPS

KINEMATICS -- the reason why Loewy flying shears perform with unerring accuracy



General view of Loewy flying shear and pinch rollers behind billet mill at the Keystone Steel and Wire Co., Peoria, Ill.

Close-up of flying shear as viewed from pinch roller side

Billet approaching flying shear

Shear cycle starts

Cutting operation

Cut finished

Installed behind a continuous billet mill, the electrically operated Loewy oscillating flying shear is indeed an extraordinary precision tool. Its speed is synchronized with the speed of the mill. Its adjustability conforms exactly with the material coming from the mill. Sequence of cuts and cut length of material can be changed at will.

The kinematics of the knife blades—a patented feature of Loewy flying shears—is the dominant factor in achieving clean cuts without any distortion of the billet. For each individual cut an automatic oscillating lever mechanism actuates the shear and then returns the blades to their initial position at the end of the cycle.

The flying shear is a part of the complete Loewy billet handling system: skew-roll grouping tables behind the shear, billet cooling beds, and runout tables from where the material is selectively kicked off into collecting pockets. The shear itself can, of course, be furnished for an already existing system.

All B-L-H machinery is designed and built to our customers' requirements. B-L-H's Industrial Equipment Division builds Loewy rolling mills and auxiliary equipment, as well as Loewy hydraulic machinery. To avail yourself of our services, write Dept. F-10.

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MECHANICAL ENGINEERING

VOLUME 82 • NUMBER 10 • OCTOBER, 1960

For the 50th Time

With the mailing of the 1961 ASME "Mechanical Catalog" this month, the Society reaches another milestone in its publishing history. For this 50th Edition marks the "Mechanical Catalog's" Golden Anniversary—an ASME service that has provided mechanical engineers with a compact, easy reference volume containing the sources and descriptions of the engineered products they buy and specify.

In the new "Mechanical Catalog," the user will find a comprehensive, up-to-date, exclusive directory of engineered products and their sources. In addition, the "Catalog" provides a product-data section to which he can turn for detailed product descriptions.

First published in 1912 as the "Condensed Catalogues of Mechanical Equipment," it was the Society's initial publishing attempt to catalog the mechanical industries with data pages and a product directory. The 1912 edition had only 480 listings of products by 220 manufacturers. By contrast, the 50th Edition contains almost 6000 product categories listed by more than 3500 companies.

Here is a small sample of the wide range of products included in the current volume:

Steam, hydraulic, and internal-combustion engine power; electric machinery; instruments for plant and laboratory; power-transmission apparatus; materials-handling equipment; materials of all kinds; foundry, forge, and rolling-mill equipment; machine tools; presses, hammers, shears, punches; pumps, compressors, blowers; heating, ventilating, air-conditioning, and refrigeration apparatus; tanks; steel-plate construction; crushers; pulverizers; textile machinery; woodworking machinery; wire-mill machinery; and many others.

Distribution of "Mechanical Catalog" also is unique. It is sent only to those mechanical engineers who qualify for selecting and specifying equipment, materials, and supplies and who have specifically requested it in writing. Prior to publication (in June of each year), each of ASME's nearly 50,000 members receives a notice which includes a request form. If he needs and wants the "Catalog," the member is asked to give his name, title, and nature of his work; firm name and address; and principal product or service.

Circulation of the 1961 "Catalog" is 18,000. And for the 1962 edition it is planned to increase circulation to 20,000. Reason: Requests have been outnumbering print orders.

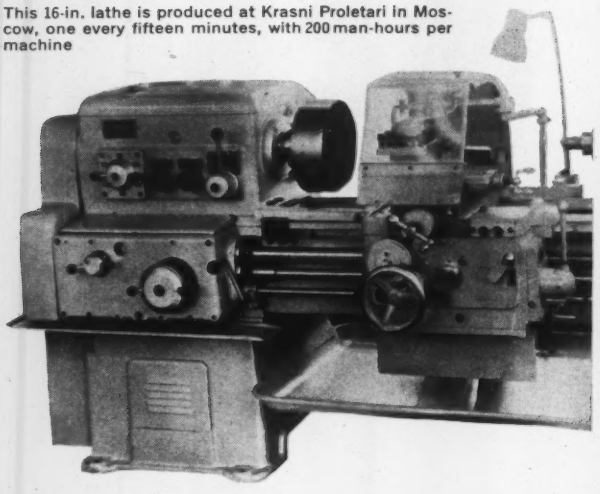
Interesting to note is the fact that research studies show that each copy of "Mechanical Catalog" is consulted by an average of at least seven persons in addition to the one who requests it; and that each user consults it approximately 30 times a year.

As ASME's "Mechanical Catalog" goes to the membership for the fiftieth time, the "Catalog" staff is already planning ahead for an even better publication. Next year, the 51st Edition will have a new format, including an expanded directory section.

The "Mechanical Catalog" is one of ASME's most valuable services. Use it. It can make your job a lot easier.

J. J Jaklitsch, Jr.

Editor, J. J. JAKLITSCH, JR.



This 16-in. lathe is produced at Krasni Proletari in Moscow, one every fifteen minutes, with 200 man-hours per machine

RUSSIA

A NEW LATHE EVERY

In the western world, machinery is typically produced in small quantities and by small-quantity methods. The technology of mass production is but rarely applied in the very industries whose products are instruments of mass production. This fact is now acquiring importance for industrial life within the western world and in the political-economic relation of the western countries to the Soviet sphere.

At the present time the countries of western Europe, owing mainly to lower wages, are able to underbid U. S. machine-tool manufacturers in most world markets. The machine-tool industries of the Soviet sphere, however, have been underselling both western Europe[2] and the United States. The strategic fact here is that parts of the machine-tool industries of the Soviet Union are already operating on a mass-production basis, and vigorous efforts are being made to extend these methods. In a contest between Soviet mass-producing industries and Western small-quantity production, the mass-producing Soviet industries will be victors on the world market. There will be increasing pressure both within the countries of the West, as well as in Asia, Africa, and South America, to purchase machinery from the lowest-price producer. The mass-produced item will be cheapest.

The Soviet Strategy

A leading position as supplier of equipment for industrialization is the basis of a range of connections which, in sum, equal political influence. The buildup of mass production of machinery in the Soviet sphere represents a major strategic bid for the areas of the earth that include the largest part of humanity. This is the Soviet bid for victory under conditions of peaceful competitive coexistence. It is publicly announced.

The machinery-producing industries of the West labor under two major difficulties with respect to introducing mass-production methods. First, these industries, owing to their long history, are often composed of many firms, of medium and small size, with traditions of highly individualistic managements. Second, these industries have often suffered from great instability of their markets. This can make investment in mass-production facilities seem outlandish in terms of the financial risks involved. A managerial and technical tradition has grown up which justifies the traditional conditions.

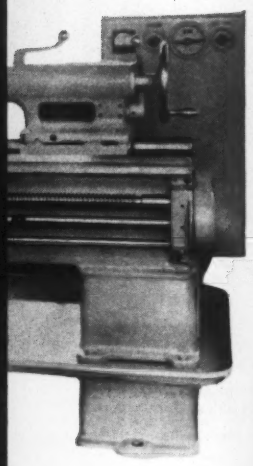
The plain fact is that there is nothing in the nature of the product of the machinery-producing industries that should exclude application of mass-production technique.

The Soviets are applying technical intelligence to machinery production. The effects that flow from that fact are therefore not owing to anything that the Soviets are doing to the West. A problem arises here because there continues to be a major withholding of mass-production technology in the countries of the West from within the machinery-producing industries.

[1] Associate Professor of Industrial and Management Engineering. Professor Melman is preparing a volume on "Western and Soviet Efficiency in Machinery Production" for publication early in 1961.

[2] S. Melman, "Report on Productivity of Operations in the Machine Tool Industry in Western Europe," European Productivity Agency, Paris, France, October, 1959. Copies of this report can be requested from the office of the E.P.A. at 1346 Connecticut Avenue, Washington, D. C.

Based on an address, originally titled "The Crisis in Machinery Production," and delivered at the Productivity Luncheon of the Production Engineering Conference, Milwaukee, Wis., May 17–19, 1960, of The American Society of Mechanical Engineers.



The Soviet Union is striving to mass produce its machine tools. Low-cost machinery will facilitate Soviet and Chinese industrialization and productivity, and will give the USSR a preferred world-market position.

15 MINUTES

By **Seymour Melman**,[1] Assoc. Mem. ASME, Columbia University, New York, N.Y.

The machine-tool industry exemplifies the problems of the machinery-producing industries, both in the United States and in western Europe. A few of the Western industries, like automobile, tractor, parts of the electrical-goods industries, and a few machine-tool factories, do not reflect the average condition.

On the world machinery market American-produced machines are typically high-priced equipment. The conventional view assigns primary responsibility for this to the high money wages to workers in the United States. This conventional assumption deserves analysis.

Are High Wages Responsible?

While money wages are the highest in the world, the prices of American-produced goods compared with foreign goods show smaller differences than the gaps in wages. Indeed, in some important cases, the prices of U. S.-produced goods have been the lowest in the world.

Comparisons of world automobile prices in 1956 disclosed that the factory price per pound of car was lowest in the United States.[3] The combination of lowest price per pound of vehicle with the world's highest wages was made possible by high productivity in the use of both labor and capital. In the United States the cost of electric power to industrial users has remained relatively stable, at current prices, during the past half century, despite marked growth in the costs of fuel, machinery, and the wages of employees.[4]

High wages may be combined with low unit cost of the product when high-efficiency technologies are used to operate quantity production systems at stable rates. Stability, in this context, means variation in production rate within predictable and acceptable limits. Under such conditions, the capital outlays for high capacity equipment are apportioned among many units of output. The result is relatively modest unit cost of production. This is the classic pattern which makes possible the combination of high wages with low prices. In the machine-tool industries these classic patterns of mass production are being applied mainly in the Soviet sphere.[5]

Production in the USSR

I was able, in August-September, 1959, to visit three leading factories in the Soviet machine-tool industry. They exemplify the direction of development of the industry rather than the average conditions to be found in the Soviet machine-tool industry as a whole.

The Krasni Proletari factory specializes in the manufacture of lathes—a general purpose lathe, and special lathes of all sorts. The standard machine is a large 16-in. lathe classed as being suitable for many toolroom purposes as well as for general factory use. It has a rated precision of about 0.002 in. This machine is produced in a production system that utilizes about 1000 of the 4000 workers in the Krasni Proletari factory. The equipment in this section of the factory is similar in many respects to the lines of an automobile factory. It is the only factory of its sort that I have ever seen that is

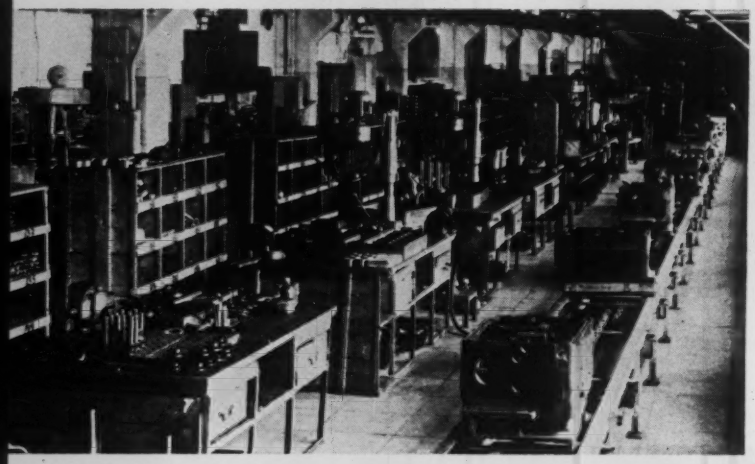
[3] W. A. Hadley, "Why the U. S. Is Strong," Mechanical Engineering, September, 1956, pp. 820-822.

[4] S. Melman, "Dynamic Factors in Industrial Productivity," John Wiley & Sons, Inc., New York, N. Y., 1956, p. 206.

[5] See also the paper by Dr. D. F. Galloway, "Recent Production Developments in the Soviet Union," the Institution of Production Engineers, London, 1959.

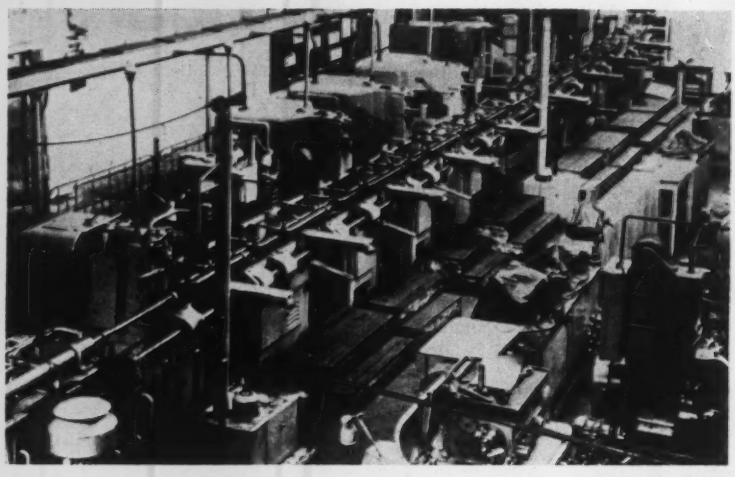
RUSSIA

A NEW LATHE EVERY 15 MINUTES



Conveyerized assembly line for main gearbox of the 16-in. lathe. The production cycle there is about 10 days compared with six to eight weeks in Western machine-tool plants.

One hall of an elaborate machine-tool exhibition in Moscow. The billboard declares the importance of using standardized components for building machines.



This automatic line at Krasni Proletari receives steel blanks and produces inspected gears. Such equipment is unknown in the machine-tool factories of the Western countries.

equipped with transfer-type machines and automatic gear lines. Power conveyers are widely used. The general layout of the plant is quite systematic despite the crowded and difficult conditions of work within a series of buildings that date back more than a century.

These lathes are produced at the rate of one every fifteen minutes from the finishing conveyer line, and their production requires an average of 200 man-hours of labor per machine. The usual array of electrical parts, roller bearings, and major castings come from outside supplier plants. Similar machines are produced in western Europe with a requirement of about 600 to 850 man-hours per machine. Such factories in western Europe or the United States do not utilize the automatic equipment and the conveyerized type of operation that is used in Krasni Proletari. Neither do any of them have the rate of production that is observed there.

The production cycle time in this factory is worth special attention. The lathes produced as standard products were being shipped at an average of about 10 days' total elapsed time from raw material stores to shipment of the finished product. This is a strikingly shorter time than the production cycle time that is usually found in machine-tool factories, but is altogether plausible under mass-production conditions.

Conditions of Work

Broadly, the conditions of work in this factory would be regarded as substandard by workers in the U. S. and western Europe, in terms of cleanliness, ventilation, orderliness in and around the various machines, and the like. I was struck by the strenuous work pace that is maintained in this plant. The workers are paid on the basis of piecework with each operation given its own time standard. These time standards are clearly "tight" and the workers were pushed to considerable exertion in order to maintain the weekly wage. Poor housekeeping was the rule in this factory and the others that I saw.

Second was the Ordjonikidze factory, also located in the Moscow region. This plant has specialized in the

production of transfer-type machines for mass-production industries and multiple spindle automatic lathes. The latter are produced at the rate of one per day. The Ordjonikidze factory has its own extensive design, toolmaking, and measurement laboratories. The latter included the full range of high-precision equipment for calibrating gages and other precision devices used for control of dimensions in production.

The Sverdlov factory in Leningrad specializes in the manufacture of large boring, planing, and milling machines, including Keller-type, and a 110-mm-spindle horizontal borer. One of these latter machines is completed each working day, requiring about 2000 man-hours of labor per machine. The productivity rate of 2000 man-hours per machine compares with requirements of as much as five times that many man-hours for similar machines in Western plants where such tools are produced intermittently and in small batches.

The Sverdlov plant also produces punched-card-type numerical control equipment for the boring machine. This equipment is impressively inexpensive, being priced at about half the domestic price of the machine tool itself. For similar equipment the ratio in the U. S. and western Europe is approximately 1:1. The Sverdlov factory was getting the benefits of quantity production technique in the control equipment, too.

These three factories are regarded as among the best plants in the Soviet Union machine-tool industry. They are not models of mass-production technology, on the basis of the level of such technique in the U. S. They are, however, good examples of the benefits from specialized production, and production of machines in large batches or in continuous series. From this standpoint these factories show developments that have virtually no counterparts in the West. Furthermore, these plants are important in so far as they represent a direction of development for the Soviet industry, a direction which receives encouragement of every sort.

What of the quality of the machines produced in these factories? Without a full-scale analysis and testing program it is not possible to give a conclusive statement on this matter. The available information from users is that they are ruggedly built, with precision where it counts, and lesser attention to appearances.

The Price Tags

What about Soviet machinery prices? The following statistics compare U. S. and Soviet prices for two machine tools: a lathe, and a medium-sized horizontal boring machine. The lathe is the model that is mass-produced at the Krasni Proletari factory, and the boring machine is the one that is manufactured at the Sverdlov factory.

	Soviet domestic price (rubles)	Soviet domestic price converted to dollars at 4:1—the official rate	Soviet domestic price converted to dollars at 10:1—the tourist rate	Soviet price in west Europe (dollars)	U. S. price of similar machine made in U. S. (dollars)
Lathe	14,000	3,667	1,400	3,800	10,000
Boring machine	135,000	33,750	13,500	26,000	46,000

Officers of Stankoimport, the Soviet machinery trading organization, state that their pricing is done with an eye to the following considerations: The domestic price of the machine which they must pay to the enterprise that produces it; the value of rubles to dollars, for which they use the official rate of the State Bank of four to one; the prices of comparable goods in countries where they wish to sell; and finally, the worth of making an attractive offer in order to establish a foothold in a new market. Such tactical considerations clearly make possible a range of prices, depending on the importance that is given to any one factor.

Against these pricing possibilities there are the underlying physical facts of relative efficiency in production.

Within each industrial country the prices at which good machines are available, compared with the cost of labor, determines whether more or less automatic methods are used in production.[4] For the U. S. and the Soviet Union we can compare the annual cost of a worker's labor in the machine-tool industry with the price of a commonly used machine-tool, in this case a 16-in. production lathe. In the United States a year of machinery-industry labor (2000 hours at $2.50 per hour) amounts to $5000. This compares with the price of a relevant machine at $10,000. Hence, the relative cost of labor to machinery by this mode of comparison is 0.5. In the Soviet Union the cost of a year of labor to a machinery-industry plant manager (2000 hours at 5 rubles an hour) is 10,000 rubles, and relates to the price of the lathe at 14,000 rubles, yielding a ratio of 0.71.

In this case a Soviet man-year of labor buys more machinery than a U.S. man-year. This is a direct result of the use of mass-production methods for the production of this particular machine in Moscow, as contrasted to small quantity methods in the West.

In the United States there has been a failure to apply elementary techniques like ordered variety (standardization) to the new and important class of numerical control equipment for machine tools. That will, automatically, make for high cost and price, and will thereby restrict the market by limiting the range of operations to which such equipment may be applied economically.

It Can't Be Done?

In the past, the machinery-producing industries have not had the kind of rapidly expanding market that has attracted to other industries the sort of financier-organizer who has put the operation of many industries like chemicals, electronics, automobiles, and others on a mass-production basis. At the same time, the managers of the machine-tool industries have developed an ideology for justifying the continuation of their mode of small quantity, small plant operation. They have held that machines of this type cannot be mass produced. The facts of the case do not support that proposition. They have held that standardization is not technically possible and would retard technological development. This is not supported by the experience of other industries that have utilized these methods.

More recently, it has been argued that the Russians, the Chinese, and their allies are probably incapable of producing high-grade special machines. Therefore the design and construction of such equipment would probably be a continuing basis for the prosperity of western firms. Observations in the Soviet Union definitely contradict such reasoning.

There is no escaping the inference that the machine-tool and other machinery-producing industries of the United States and western Europe require drastic reorganization in methods and structure. If the need for drastic improvement in productivity and reduction in price are held in view, then engineering intelligence can produce a range of methods for attaining these goals. We must combine high productivity with freedom.

ONE shaft Gas-Turbines in

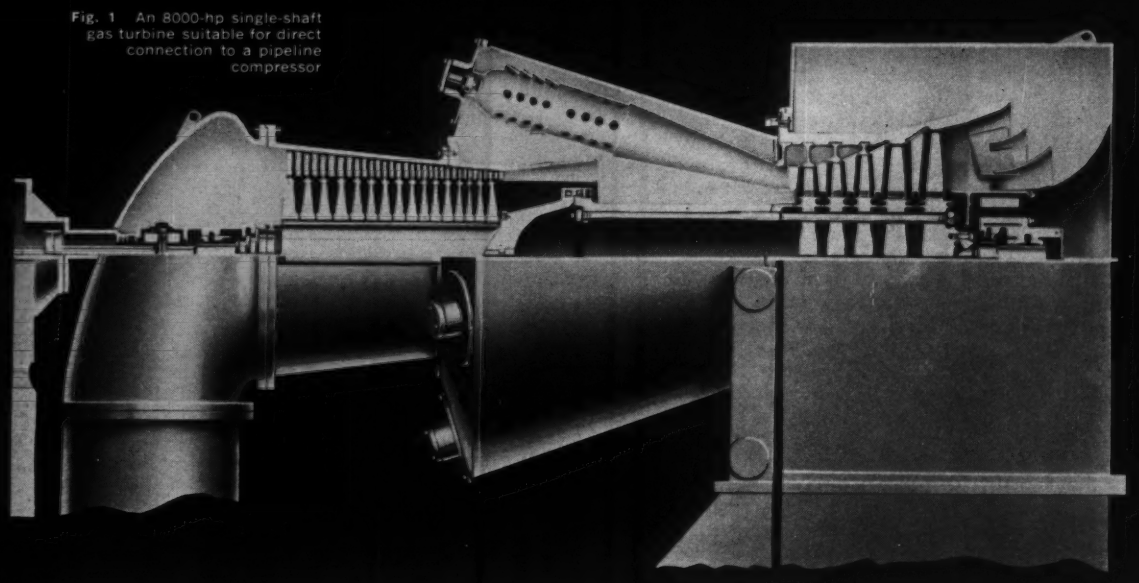


Fig. 1 An 8000-hp single-shaft gas turbine suitable for direct connection to a pipeline compressor

On the one hand, the single-shaft design offers lower initial cost. On the

IN THE brief span of 10 years, the gas turbine has advanced from experimental to accepted use as a proved prime mover for pipelines. Coupled to a centrifugal compressor it is low in cost and reliable.

Although the more complex gas-turbine cycles involving intercooling, reheat, and regeneration permit cycle efficiencies comparable to those of any other type of prime mover, low installed cost is one of the most important considerations in the pipeline industry. Only two types should be considered for such application:

These are the open-cycle, single-shaft unit and the open-cycle, two-shaft unit. Either cycle can be equipped with a regenerative heat exchanger which utilizes the hot turbine-exhaust gases to preheat the combustion air and provides approximately 25 to 40 per cent improvement in cycle efficiency. This gain is a function of the cycle pressure ratio. For a given turbine-inlet temperature, a low-pressure-ratio cycle will show a considerably larger gain in efficiency from regeneration than a high-pressure-ratio cycle. The lower temperature from the axial compressor and the higher temperature from the turbine provide a higher temperature differential to return heat to the cycle.

The choice of a regenerative-cycle or a simple-cycle gas turbine for a given application requires economic evaluation. To justify the regenerative cycle, the higher first cost must be offset by decreased operating expenses. This is a function of fuel cost and load factors, and the break-even point can be determined for any application. Frequently the simple cycle is the proper choice for stations near the gathering fields, while the regenerative cycle is the proper choice for stations near the delivery end of the line.

While the simple versus regenerative choice is purely economic, the single-shaft or two-shaft choice depends entirely on the combined performance characteristics of gas turbine, driven compressor, and pipeline. Both types provide relatively low installation and operating

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versus TWO

Gas-Line Pumping

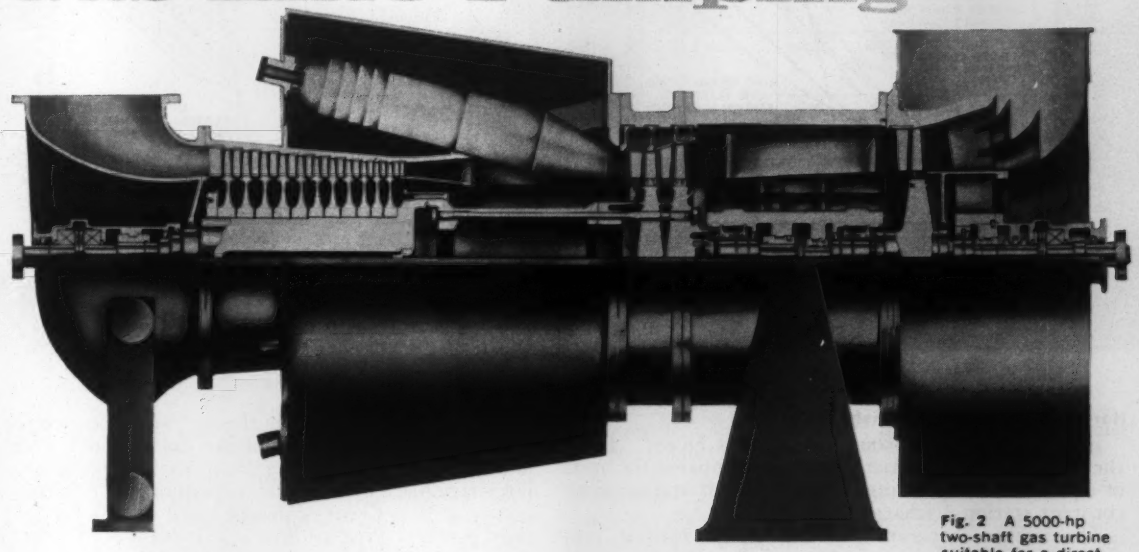

Fig. 2 A 5000-hp two-shaft gas turbine suitable for a direct connection of the power turbine shaft to a pipeline compressor

By Mark J. McDonough, Design Engineer, Industrial Gas Turbine Dept., Westinghouse Electric Corporation, Lester, Pa.

other, the two-shaft unit will use less fuel during period of low flow.

costs, although the single-shaft unit has a decided advantage and should always be chosen where the flexibility requirements are adequate. Since the author's company builds both types, an unbiased evaluation will be attempted.

Description

In the 8000-hp single-shaft gas turbine suitable for direct connection to a pipeline compressor, shown in Fig. 1, the five axial-flow turbine stages are directly connected to the axial-flow compressor consisting of 16 stages. The turbine element develops approximately $1^1/_2$ times the power required by the axial compressor. For a unit rated at 8000-hp output, the turbine element develops some 24,000 hp of which 16,000 hp is required by the axial-compressor element. The driven equipment—in this case a centrifugal-flow, gas-line compressor—is directly connected to the gas-turbine shaft at the compressor end of the unit. Because of this direct connection to the compressor-turbine shaft, the speed variation is dependent on the design of the gas turbine. At speeds lower than design, power output is limited either by the surge-line characteristics of the axial-flow compressor or by over-temperature of the gas turbine. Some further flexibility may be obtained by the use of an interstage bleed line on the gas-turbine compressor when compressor surge is the limiting item. This effectively increases the axial-compressor surge margin at speeds lower than design.

A 5000-hp two-shaft gas turbine, shown in Fig. 2, is suitable for a direct connection of the power turbine shaft to a pipeline compressor. In the gas-generator portion of the machine, two axial-flow turbine stages are directly connected to the axial-flow compressor, and the single-stage power turbine is mechanically independent of the compressor compressor-turbine shaft. In a sense, the power turbine acts essentially as a hydraulic coupling between the power-producing elements and the driven load. Therefore the output-speed variation is dependent on the speed-power characteristics of the load. For two-shaft units in gas-line pumping applications, it is always the surge-line characteristics of the driven pipeline compressor which impose the lower limit of operation.

ONE shaft versus TWO

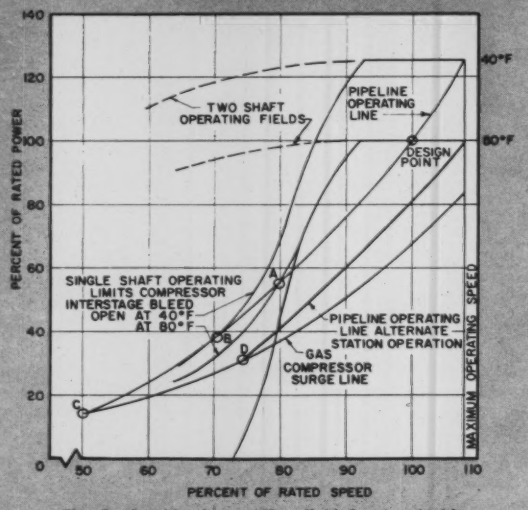

Fig. 3 Combined operating field for gas turbine, compressor, and pipeline at constant station-discharge pressure

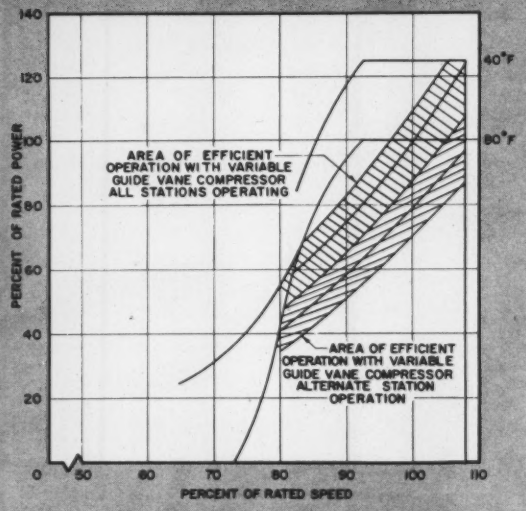
PERCENT OF RATED POWER
PERCENT OF RATED SPEED
AREA OF EFFICIENT OPERATION WITH VARIABLE GUIDE VANE COMPRESSOR ALL STATIONS OPERATING
AREA OF EFFICIENT OPERATION WITH VARIABLE GUIDE VANE COMPRESSOR ALTERNATE STATION OPERATION
40°F
80°F

Fig. 4 Pipeline flow variations of single-shaft units can be increased to a point approximately equal to that of two-shaft units

Horsepower-Speed Relationship

In any comparison, some limits must be set. Here, the operating characteristics will be compared for units of equal power operating in a single-unit station with constant station-discharge pressure.

The combined operating field of the gas turbine, centrifugal compressor, and pipeline for 40 and 80-F ambient is shown in Fig. 3. The power output of a gas turbine operating at 40 F and below is approximately 125 per cent of rated power. To take advantage of the increased capability at low ambients, the gas turbine and centrifugal compressor must be matched in such a way that the added capability can be applied to the line without exceeding the maximum speed of the gas turbine.

For constant station-discharge pressure, the additional low-ambient output can be applied to the line only by increasing the speed of the centrifugal compressor, thereby increasing the flow. Therefore, the speed-horsepower relationships of the pipeline, gas turbine, and centrifugal compressor must be studied in line with the expected ambient temperature in order to match efficiently the gas turbine and centrifugal compressor to provide maximum operating flexibility. Single-shaft gas turbines can provide approximately ±8 per cent speed variation at full load. If the turbine and centrifugal compressor are matched at rated speed at rated load on an 80-F day, there will be sufficient speed margin so that 125 per cent of rated power can be applied to the line at ambients of 40 F and lower. The operating line in Fig. 3, with all stations operating, is shown matched at 100 per cent speed at 80 F, which provides a speed of 108 per cent at 125 per cent power at temperatures of 40 F and lower. Thus at 125 per cent power output, maximum turbine speed has not been exceeded, and the equipment can be operated safely.

For a properly matched single-shaft gas-turbine centrifugal-compressor power plant, the lower limit of operation along the gas-compressor operating line for the turbine being studied is set by the surge-line characteristics of the compressor element of the gas turbine. Point A in Fig. 3 is the operating limit with the compressor-interstage bleed open for an ambient of 80 F. This limit occurs at 79 per cent of design speed and 54 per cent of rated power. Pipeline flow at this point is 82.5 per cent of design flow. For operation at 40-F ambient temperature, the gas-turbine operating field expands slightly, as shown, and the operating limit shifts to point B, which occurs at 71 per cent design speed and 38 per cent of rated power. The pipeline flow at this point is 74 per cent of design flow. Thus, on a 40-F day, pipeline-flow variation from 74 to 104 per cent is possible with all stations operating and each station discharging at constant pressure.

For two-shaft operation, the lower limit of operation is set by the intersection of the operating line and the gas-compressor surge line—point C in Fig. 3. It occurs at 50 per cent speed and 14 per cent rated power. Pipeline flow at this point is 44 per cent of design flow. Thus a two-shaft gas turbine provides a variation of pipeline flow from 44 to 100 per cent on an 80-F day and from 44 to 104 per cent on a 40-F day.

There are various ways to increase the possible pipeline flow variations of single-shaft units to a point approximately equal to the variation possible with two-shaft units. The most efficient method of accomplishing this is by the use of inlet guide vanes on the centrifugal compressor which add additional flexibility, Fig. 4. With some sacrifice in line packing but with a saving in operating labor, an effective way of obtaining increased flow variation at constant station-discharge pressure is by alternate-station operation. The gas-compressor operating line for alternate-station operation is also shown in Fig. 3. The lower limit of pipeline flow with alternate stations operating is set by the intersection of the alternate-station operating line and the gas-compressor surge line. This is shown by point D and occurs

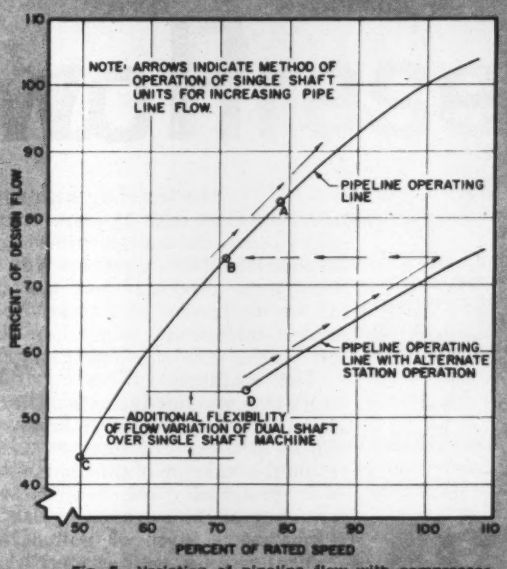

Fig. 5 Variation of pipeline flow with compressor speed along the two operating lines shown in Fig. 3

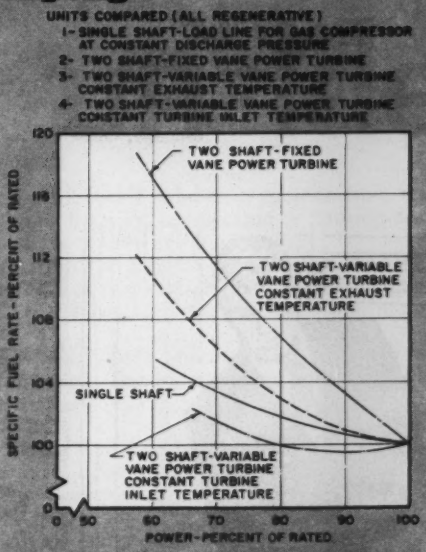

Fig. 6 Comparison of fuel rates of regenerative gas turbines driving pipeline compressors

at 74 per cent speed and 31 per cent rated power. Pipeline flow is 54 per cent design flow. Thus, for a single-shaft unit, flow variation from 54 to 100 per cent is possible on an 80-F day by a combination of speed variation and alternate-station operation with still further flow reduction possible by the use of compressor-inlet guide vanes. The two-shaft gas turbine which is often thought of as having considerably greater flexibility than the single-shaft unit is in reality capable of handling only about 10 per cent greater pipeline-flow variation. It should be noted that this increased flexibility only occurs at the lower portion of the operating field; the lower limit of operation being set by the surge-line characteristics of the driven centrifugal compressor and not by the prime mover. Fig. 5 presents the variation of pipeline flow with speed along the two operating lines shown in Fig. 3.

Efficiency Variations at Part Load

When the efficiency of the unit is of prime importance, a regenerative-cycle gas turbine should be chosen when it can be determined that the higher initial cost can be offset by savings realized by decreased fuel consumption. The variation of specific fuel consumption is shown in Fig. 6 as a function of per cent of rated power for four different configurations, all of which are regenerative. As shown, the part-load efficiency of the single-shaft regenerative gas turbine is exceeded only by a two-shaft gas turbine equipped with variable power-turbine diaphragms to provide constant turbine-exhaust temperature at part-load operation. However, if turbine-exhaust temperature at rated power is near the regenerator maximum temperature, then this latter method of operation is not possible since turbine-exhaust temperature and hence regenerator-inlet temperature would increase at part load if turbine-inlet temperature is held constant. Therefore the single-shaft regenerative gas turbine will provide a higher part-load efficiency where the exhaust temperature is limiting—a fact that has not always been appreciated fully.

Conclusion

For the operator to evaluate whether a single-shaft or two-shaft unit is required, the load factor must be considered to determine the amount of operation in the 44 to 54 per cent flow region where the single-shaft gas turbine would require recirculation. The greater fuel consumption of a single-shaft unit because of the recirculation during periods of low flow, that is, usually weekends during summer operation, must be weighed against the lower initial installed cost of the single-shaft machine. Currently, this is approximately $10 per installed horsepower.

For the final evaluation there are other operational characteristics to be considered: It is difficult to prevent overspeed of the gas compressor during line upset with the two-shaft installation, whereas good speed and line-upset control are provided in the single-shaft unit since the gas compressor is connected to the complete turbine. As far as maintenance is concerned, there are six journal and three thrust bearings on the two-shaft unit and only four journal and two thrust bearings on the other. Gas-compressor thrust bearings and seals are started under load with the two-shaft unit and at no load with the single-shaft. Operation of the two-shaft unit is simple since the centrifugal compressor is started while pressurized, whereas starting is accomplished on the single-shaft unit with the centrifugal-compressor casing depressurized, and loading is accomplished by pressurizing the centrifugal compressor after the gas turbine is past self-sustaining speed.

There are applications for both types of gas turbines depending upon the gas-line load factor. For low load-factor lines the two-shaft would generally be the choice and for high load-factor lines the single-shaft gas turbine is preferred because of its simplicity and good efficiency.

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How

Are you speaking the other fellow's language—or your own? First of all: Did you listen to the statement of the problem?

In meeting with engineers for more than 25 years—sometimes across the desk, at other times in conferences where perhaps a dozen men were involved—few had the ability to present in a clear, lucid, easy-to-understand way ideas that often were very worth while.

The weakness in putting their story over was not due to inability to talk, nor a lack of skill in language. These men did not seem to understand the make-up of the communication processes. The function and structure of the means by which information is given or gotten were either not appreciated or more likely not understood.

For part of their working life, engineers live eight or more hours each day in the unreal world of the Engineering Department. That world is filled with definite objectives and precise values plus symbols which are unique—having generally only one referent or object for which the symbol may be used. They talk in these special ways: Mathematics, physical properties, absolute standards, ASME codes, and so on.

A Nearly Universal Language

In short, with these aids they can create a design and detail it. It can be sent to any of a dozen foreign lands. There, despite language differences, the parts can be manufactured to acceptable standards. In one sense these engineers have constructed a nearly universal language of their own. It works! In fact, it works far better than any other international device so far designed for the exchanging of useful and desirable information.

In this world with its restrictive symbols one doesn't specify, "stainless steel" on a bill of material. The engineer knows better. He knows and is keenly aware that "stainless steel" may stand for some 300 metals. "Stainless Type 347," or any other type, is a definite material fixed by a rigid code within narrow limits.

Contributed by the Management Division and presented at the Summer Annual Meeting, Dallas, Texas, June 5–9, 1960, of The American Society of Mechanical Engineers. Condensed from Paper No. 60—SA-32 originally entitled "What Can an Engineer Do to Break the Communication Barrier?"

to Present an Idea

Stainless steel on the other hand is one of the vague outside-world symbols on which an engineer cannot rely unquestioningly.

Few engineers show signs of recognizing how impossible it is to assign fixed values to the symbols and words with which our ordinary day-to-day talking is done.

There are an estimated 600,000 words in the largest English-language dictionary. These are forced to serve to describe the billions upon billions of objects or the events and transactions which are constantly taking place all about us.

Few engineers—or others for that matter—have control of a general language vocabulary of more than 25,000 words (apart from their work-a-day technical words). This can be put another way. They are compelled to get by with 25/600 or less than 5 per cent of the available words when they try to tell a layman, who does not know their shop talk, or trade jargon, about their ideas.

Engineers are able to build wonderful machines, devise complex systems, and create interlocking processes because they are all, in the final analysis, step-by-step functions. No matter how seemingly complicated, these are progressive—all have one step or action following or paralleling a previous action.

Presenting an Idea

Idea presentation is not simple, rigid, or especially predictable.

Whereas a machine or process will have control and instrument centers which accurately show where and to what degree malfunctioning exists, "man-to-man" talking has no such aids.

When the engineer tries to tell "the other fellow," he's on his own. No dials! No circuit breakers! No aids!

Here he's probably more uncomfortable than any other specialist because he cannot test the situation to see how it's going!

Tape recordings of engineers trying to tell management what would be accomplished if their recommendations were followed have been made by the author's company. Reruns of these tapes have been most instructive. Time after time verbal impasses developed. Time after time there was a "bogging down" over a technical phrase in a layman's discussion.

Why these impasses? There are two broad categories into which the answers fall. Each has to do with understanding, rapport, "being in the other fellow's shoes" type problems.

Most people, including engineers, tend to talk with their everyday vocabularies. Unfortunately, the everyday vocabulary of the specializing engineer is not one with which most laymen are comfortable.

Most of the common words which we use every day have to work overtime. Each one must do many jobs, serve many purposes, to make those 600,000 words stand for billions upon billions of events, objects, or situations.

Take the word "strike." It can refer to a labor dispute, to hooking a fish, a score in bowling, a lack of score in baseball, causing an arc to form between electrodes, achieving a balance in computation, making and ratifying a bargain, or lowering or hauling down a flag. These are just a few of its many uses.

Most common English words are of the same order of preciseness as our earlier example of "stainless steel," which could mean any one of some 300 or more formulations.

Then too, words change their meanings with each passing year. The 16-yr old and the 76-yr old each can use identical words in a manner equally unintelligible to the other.

Snails, in San Francisco, are not things which run, or rather crawl, but a type of sweet roll. This is just one of many variations in meaning resulting from differences in local usage.

There are many other factors which contribute to the variable character of words and a study of them is rewarding.[1] The late Irving J. Lee was an authority on this subject.[2] He would frequently say, "Words don't mean. It's the people who use the words who mean. The 'meaning' is in the person who has chosen that word or those words to convey his meaning."

Another of his comments was: "Words are not to be thought of as containers, out of which meanings pour as the container is tipped . . . something instantly identifiable as 'being the same' by all who see it."

Vocabulary Dwindles With Age

As most of us get older, our stock of general words tends to dwindle. Most people have their peak vocabularies immediately after they complete their formal education, be it high school, college, or postgraduate work.

Thereafter they start devoting eight or more hours a day to the arduous task of learning to earn a living. During this intense period a new vocabulary usually begins to displace part of the general one acquired before working.

In short, a "trade or technical jargon" is assimilated. The more specialized and restricted the field the more rapid and complete the assimilation becomes.

A general practitioner of medicine will be less affected than will the research man or the development engineer. The general practitioner must use a work-a-day-with-people talk. The other two do not.

The average man who at 22 had 20,000 to 25,000 words

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[1] See: Irving J. Lee, "Language Habits in Human Affairs," New York, Harper & Brothers, 1941; S. I. Hayakawa, "Language in Thought and Action," New York, Harcourt, Brace & Company, 1949; Stuart Chase, "The Power of Words," New York, Harcourt, Brace & Company, 1953; Rudolph Flesch, "The Art of Readable Writing," New York, Harper & Brothers, 1949; Ralph G. Nichols and L. A. Stevens, "Are You Listening?" New York, McGraw-Hill Book Company, Inc., 1957; Irving J. Lee and Laura L. Lee, "Handling Barriers in Communication, New York, Harper & Brothers, 1957.

[2] Dr. Lee, chairman of the Department of Public Speaking, Northwestern University, also was a consultant on communication for such companies as: Illinois Bell Telephone Company; Commonwealth Edison Company; Pure Oil Company; Western Electric; People's Gas, Light and Coke Company; General Electric; Wallace Supplies Manufacturing Company; G. D. Searle and Company; Johnson Wax Company; and American Maize Products Company.

How to Present an Idea

in his general vocabulary has lost nearly half of them by the time he reaches 45. In their place, he will have added a thousand or so often-used job words. Unfortunately, because of habituation, he will carry these out of the shop-talk setting into discussions with laymen where many of them will be completely undecipherable.

This, in so far as engineers are concerned, is truly unfortunate. One of our richest sources for new, vital, labor and energy-conserving ideas is the engineering group. Society loses many valuable ideas because they stay hidden in the sketches or minds of these men who all too frequently are unable to communicate them to others.

In a discussion of this problem someone asked, half jokingly, "What should these fellows do? Practice on their mothers? Their wives?"

This seemingly silly series of questions may have value. Were they to try such explanation they would be compelled to review and restate their ideas in layman's language.

The transition from the role of creating ideas to explaining them is not an easy one to make. This is especially true for the person who thinks in formulas, mathematical concepts, schematics, and other highly specialized terms. Frequently the people who must listen and understand before they can judge fairly the merits of an idea are laymen.

Even more unfortunately they are often profit-conscious and have their own comfortable trade talk which is apt to be the jargon of the financial world or the world of accounting. In this case the engineer is doubly burdened. He not only must untrack himself from his comfortable paths but he would gain much if he could rephrase his values into their language.

There is still another major obstacle that engineers, who want their ideas sold, must surmount. Almost without exception every idea must be verbalized before it can be made for sale. The sales end of the business must be able to describe it with "words." The words must carry a clear, money-loosening force if the "buyer-to-be" is to be moved to buy. When the matter of contracts arises, lawyers too must be able to understand and agree on what's to be expected.

There are people who specialize in translating the engineer's story to lay people, but most events lose something if they are heard through an interpreter.

The second area in which communication difficulties arise with engineers has absolutely nothing to do with either the ability to talk or any of the communicating skills generally thought to be important.

The second area deals with a weakness common to a very large segment of the general population.

Ability to Listen

Listening! The ability to listen through a situation or meeting is a rare trait in so far as engineers are concerned. On occasions too numerous to count I have seen engineers in conferences pop out with problem-solving comments. The only thing wrong was that in most of those situations the problem had not yet been stated in full.

To speak out intelligently in a conference situation, enough listening must be done to have an awareness of the nature of the problem area. A man who comes to a conference, solution in hand; who sits around waiting for his chance to set the conferees straight; who, instead of hearing what others are saying, is busy putting the finishing touches on his own gem, is apt to sound rather silly when he finally does let go.

The engineer with his ideas would do well to listen—with his whole mind—to the problem statements of the others. Then he could check his evaluation of the situation to see if others see the problem in the same way he has seen it. If this checked-out situation is a suitable place for his ideas, he can then talk freely of them and be sure the others will be more attentive than they would have been if he had blurted out his pet theory earlier.

In "Are You Listening?" Nichols and Stevens report that tests run to check listening skills showed that peak attentiveness to talk occurs in the lower grades of grammar school. A marked falling off of listening ability occurs as the youngster moves through high school toward college.

At the very time he moves from an essentially "read and learn" situation into one primarily "listen and learn," he is least prepared to listen!

It is a safe bet that the vast majority of adults have had no training in the art of being a good listener.

What is wanted most by most people in conference situations is a chance to tell—to tell what they know—and it frequently will have no value for the agenda.

Dr. Lee, who has already been mentioned, also did a great deal of work in the study of conference-type communication with a team of men who audited and studied hundreds of conferences in companies and many other types of organizations including the Air Force.

One outgrowth of this work was a book with this simple title, "How to Talk With People." In it there are many references to the need to listen, to hear, to try to understand the other fellow before "talking with" him becomes even faintly possible.

In short, the average conference table is about as difficult a place to bring out ideas as one might find.

Areas of Study

A study of some of the reference material that has been listed may throw some light on the engineer's problem and help him to realize the handicap with which he is confronted.

In capsule form, to improve your skill in communicating ideas:

1 Try using the other fellow's language. It is the one he understands best. Avoid your trade jargon or professional terminology unless you are sure he will understand you. Be certain that it is your *ideas* that you are interested in expressing rather than trying to impress your listener.

2 To make sure your ideas fit, listen to the statement of the problem. Remember that there are as many views of the situation being discussed as there are people around the conference table.

3 Ask enough questions, as a check on what you understood, to be sure that you are not alone in your interpretation.

4 Put your suggestions in the form of "benefit" statements rather than a series of "how it works" statements. Remember, the other fellows probably would like to know "what it does for the group."

The result will be better idea projection and a resultant increase in receptivity from others.

Short-Field Airliners

By Philip Donely and M. O. McKinney, Jr.
NASA Langley Research Center, Langley Field, Va.

NASA brought together a team of specialists to evaluate the characteristics and capabilities of commercial short-field aircraft. Predicted: STOL operation with an aircraft capable of VTOL

During the past year, questions received from industry and other groups indicate considerable confusion with regard to short-field aircraft for commercial operations. These questions arise as to their suitability, efficiency, and reliability, and as to the exact state of development of such vehicles.

A Team of Specialists

The NASA put together a team of specialists to derive potential configurations, possible mission profiles, optimum stage lengths, safety, and the impact of such machines on airport and traffic problems. This team included research engineers who are specialists in the performance and stability and control of VTOL[1] and STOL[1] airplanes, operating problems, and aircraft noise, helicopters, and also included the NASA pilots who have flown a number of the so-called test beds which are the forerunners of real aircraft.

The problem posed to the group was to try to evaluate the VTOL and STOL aircraft themselves, to determine how they would be operated, and to analyze the airport facilities required. A number of aircraft of various types (rotor, propeller, and jet-powered) were laid out. It was required that these machines use real engines and not rubber or paper engines that might be in existence sometime in the future. To obtain a fleet size it was assumed that whatever aircraft would derive from this study would be a replacement for the current turboprop transports in the period from 1970 to 1980. On this basis, then, we are concerned with handling traffic, potentially, of 500 to 1000 vehicles. (Table 1.)

The VTOL and STOL aircraft are compatible with conventional-aircraft operating and traffic-handling procedures. The special mission profile, Fig. 1, was devised to permit them to utilize their special capabilities to keep from becoming entangled in and slowed down by the congestion of conventional airplane traffic around large airports. This particular profile is poorer than a conventional profile from the performance standpoint, and imposes a considerable penalty on the VTOL and STOL aircraft.

Helicopters

The first machine considered was a true helicopter of advanced design (Fig. 2). It is powered by three General Electric T64 engines rated at 2500 hp with a specific fuel consumption of about 0.50 lb per hphr. There appears to be nothing unusual or extraordinary involved in the design of this machine except bringing the helicopter up to the present state-of-the-art; and it would be expected that such a machine could be developed within a fairly short time period.

A companion machine, a compound helicopter, designed to obtain a higher cruise speed, is shown in Fig. 3. This machine was also designed for the feeder-line mission and the estimated cruise speed would be about 240 knots.

Certain key performance figures of these aircraft in comparison with conventional aircraft are given in Table 2. Under the heading of field length for take-off and landing, two figures are shown. The first represents the take-off distance with all power plants operating, while the lower figure, a thousand feet in each case, represents the take-off distance with one engine out, or landing distance with one engine out.

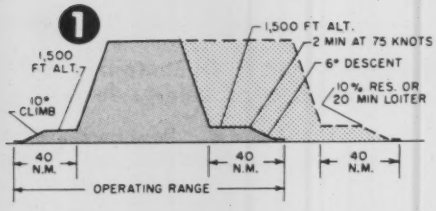
For the pure helicopter, although it has some 2500 more installed horsepower, the gross weight is the same as for the conventional airplane. The cruise speed, however, is now approximately 150 knots as compared to the 240 knots for the conventional turboprop airplane. For the compound helicopter, the gross weight is increased to some 50,000 lb in order to obtain a cruise speed of 240 knots; and the horsepower has gone up by a factor of approximately $2\frac{1}{2}$. On the basis of these figures, the helicopter would be the logical choice as a VTOL

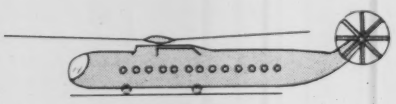
[1] Vertical Take-Off and Landing/Short Take-Off and Landing.

Contributed by the Aviation Division and presented at the Aviation Conference, Dallas, Texas, June 5–9, 1960, of The American Society of Mechanical Engineers. Condensed from ASME Paper No. 60—Av-30 entitled "Commercial VTOL/STOL Aircraft."

TABLE 1 DESIGN CONDITIONS

PAYLOAD:	
40 PASSENGERS	6800 LB
BAGGAGE	1600
CARGO	1100
TOTAL	9500 LB
RANGE:	
FEEDER-LINE	400 N.M.
SHORT-HAUL	800
AIRPORT CONDITIONS:	
ALTITUDE	2000 FT
TEMPERATURE	100 °F





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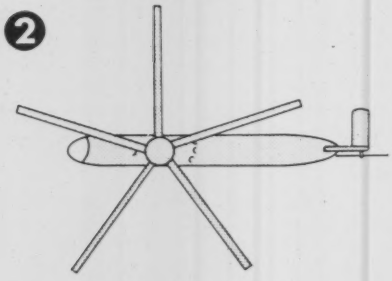

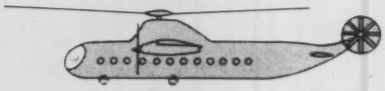

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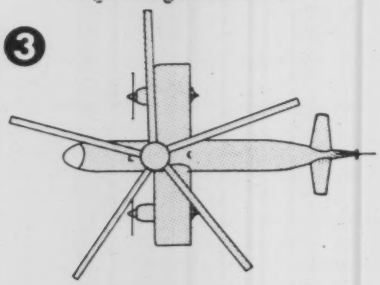


TABLE 2 FEEDER-LINE TRANSPORTS

PAYLOAD - 40 PASSENGERS (9500 LB)
OPERATING RADIUS - 400 NAUTICAL MILES

	CONVENTIONAL	HELICOPTER	COMPOUND
GROSS WEIGHT	40,000	40,000	50,000
HORSEPOWER	5,000	7,500	12,000
CRUISE SPEED, KNOTS	240	150	240
FIELD LENGTH, FT			
TAKE-OFF	3,800	0 1,000	0 1,000
LANDING	2,000	0 1,000	0 1,000

aircraft for very short flights where its low cruising speed would not be a severe handicap. The compound helicopter would be better suited to the feeder-line type operation.

Propeller-Driven VTOL/STOL

Machines of this type could involve either the so-called deflected-slipstream principle, where the forward part of the wing and the propellers remain fixed relative to the fuselage and large-chord flaps are used to deflect the slipstream and to obtain vertical lift; or the so-called tilt-wing principle in which the wing-propeller combination is tilted 90 deg to obtain vertical lift. At the present time it seems that the actual airplane would most likely be a combination of these two principles. In our studies, the most favorable type appears to be one using the tilting wing plus a wide-chord flap, to obtain VTOL with maximum hovering efficiency and to obtain good STOL capability with the same machine. It has some advantages over the pure deflected slipstream type in hovering because of the loss of energy in deflecting the slipstream; and it has advantages over the pure tilt wing because the use of the flap tends to eliminate the separation or stalling problem during the transition phase of VTOL operations.

Fig. 4 is a diagram of a VTOL tilt-wing aircraft to perform the 800-mile mission carrying 40 passengers for a total payload of 9500 lb. In this case, a large flap is used at the trailing edge of the wing and the tail-fan is provided for pitch control at very low speeds. Power plants in this airplane would consist of four RR Tyne-12 engines which would be interconnected by shafting to keep the thrust symmetrical and permit the use of all three of the remaining engines in the event of an engine failure.

This machine could also utilize eight T-64 engines, in which case two engines would be mounted in each pod. Mechanical interconnection of the propeller pitch would seem to be a very desirable feature on an aircraft such as this that relies heavily on its propulsion system in landing in view of past experience with the reliability of the propeller-pitch controls on multiengine aircraft. An interesting feature of this design is that, because of the large amount of power required for hovering, it would cruise at about 400 knots at a cruise altitude of 30,000 ft. As an example of the cost of hovering such a machine, this airplane would use about 120 lb of fuel per min for hovering.

The STOL airplane is essentially a smaller version of the machine shown in Fig. 4, the major changes being less powerful engines and a wing tilt angle of only 20 or 30 deg. In this case the power plants would be four T-64 engines and the propellers would be reduced in diameter to about 17 ft. In comparison with the VTOL airplane, the cruising speed would be somewhat less (about 340 knots at an altitude of about 20,000 ft) and the take-off distance would be somewhat larger.

Table 3 is a comparison of a conventional turboprop airplane with the STOL and VTOL aircraft. These numbers indicate that there would be a penalty of approximately 500 lb in fuel and 5000 lb in gross weight for the STOL airplane in contrast to penalties of some

Fig. 1 Mission profile chosen for the calculations. The dotted line indicates alternate-field procedure.
Fig. 2 The true helicopter. The five-bladed rotor is approximately 80-ft diam. It will carry the 40 passengers at a cruise speed of 150 knots.
Fig. 3 The compound helicopter. Stub wings, conventional power plants, and conventional tail have been added.

1500 lb in fuel and 13,000 lb in gross weight for the VTOL capability. In the case of the VTOL airplane, the power required would be about three times that for the conventional aircraft. The cruising speeds of the VTOL and STOL aircraft, however, are much higher than that of the conventional transport.

The V/STOL

The data in Table 3 show that the field length required for the STOL airplane is only about $^1/_4$ that required for the conventional transport. Two values of field length are given for the VTOL airplane. It can take off or land vertically with all four engines operating, but cannot do so with one engine out, at least not under the 2000-ft-altitude 100 F temperature conditions. For the sake of safety it should therefore be operated with a short take-off or landing run which would permit it to complete the take-off or landing successfully in the event of failure of one engine. The VTOL capability should be used only in an emergency. This VTOL airplane therefore in reality is a V/STOL airplane. The reasons for going to a V/STOL airplane instead of a true VTOL airplane with hovering capability with an engine out are largely a matter of handling qualities or operating problems (instead of performance).

Review of these configurations indicates that the STOL or V/STOL airplane suffers a relatively small penalty in weight of fuel; and it should be kept in mind that the conventional airplane is following a standard flight path, whereas the STOL and V/STOL aircraft are following an unfavorable, low-altitude, 40-mile-penetration type of profile. The V/STOL aircraft, however, involves considerable excess power and a significant increase in the gross weight of the vehicle. This penalty in power and weight would not have appeared so large, however, if the conventional airplane had been designed for the same high cruising speed as the VTOL airplane. In this case the weight of the conventional airplane would have been increased to 53,000 lb and the horsepower to 13,000.

Jet-Powered Craft

General considerations indicate that, while the deflected jet seems satisfactory for the small machine such as the Bell-X-14 test bed, the use of small light lifting engines would be a more efficient principle for the jet VTOL.

In Fig. 5 is shown one concept of VTOL jet vehicle which would perform the 800-mile mission. In this case there are two classes of power plants, the main power plants consisting of two turbofan Bristol BE.53 engines and the lifting engines which are 24 smaller turbofan engines. While the lifting engines are operating, doors would be opened to permit engine operation. Following lift-off and transition to cruising flight, the doors would be closed and the airplane would look quite conventional. The main power plants would be fitted with thrust deflectors so that the thrust could be deflected 90 deg so that they could also be utilized both for the lift-off and for the cruise condition.

A possible configuration for a jet STOL airplane is

TABLE 3 SHORT-HAUL TURBOPROP TRANSPORTS

PAYLOAD - 40 PASSENGERS (9500 LB)
OPERATING RADIUS - 800 NAUTICAL MILES

	CONVENTIONAL	STOL	VTOL
WEIGHTS, LB			
GROSS	47,000	52,000	60,000
FUEL	8,500	9,000	10,000
HORSEPOWER	6,000	10,000	22,000
CRUISE SPEED, KNOTS	260	340	400
FIELD LENGTH, FT			
TAKE-OFF	5,500	1,000	0 530
LANDING	4,200	1,300	0 780

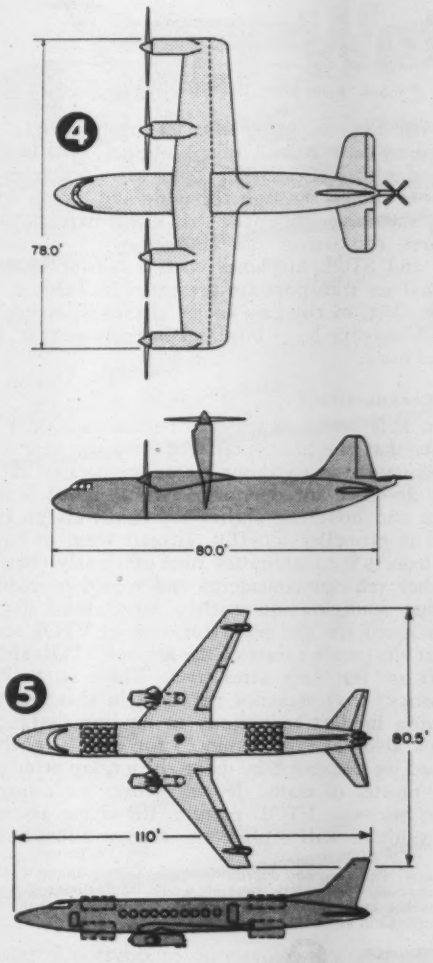


TABLE 4 SHORT-HAUL TURBOJET TRANSPORTS

PAYLOAD - 40 PASSENGERS (9500 LB)
OPERATING RANGE - 800 NAUTICAL MILES

	CONVENTIONAL	STOL	VTOL
WEIGHTS, LB			
GROSS	60,000	73,700	80,000
FUEL	16,000	23,500	23,000
ENGINE THRUST			
PROPULSION (TURBOFAN)	20,000	30,000	33,000
LIFT (TURBOFAN)		30,000	84,000
CRUISE SPEED, KNOTS	460	460	460
FIELD LENGTH, FT			
TAKE-OFF	5,000	1,300	0
LANDING	6,500	2,700	0

Fig. 4 The VTOL tilt-wing craft. The propellers are 20 ft in diam to provide the thrust required for hovering.
Fig. 5 A jet VTOL craft. Small, turbofan lifting engines are installed fore and aft of the passenger compartment. Once in cruising flight, the plane would look quite conventional.

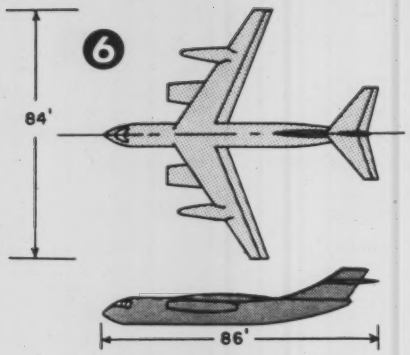


Fig. 6 A Jet STOL, using the jet-flap principle.

shown in Fig. 6, using the jet-flap principle. It is powered by four Bristol BE.53 engines, two in each of the inboard nacelles. The cold air flow from these engines is ducted through the wing and blown out as a thin jet sheet over the entire span of the flap.

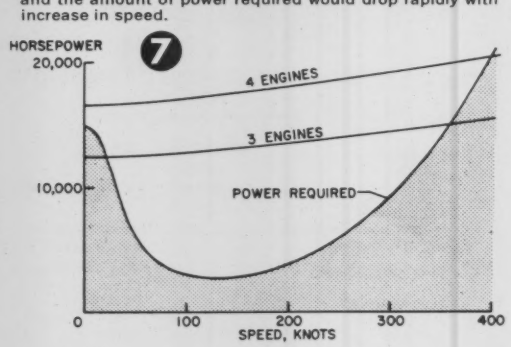
Figures comparing the characteristics of these jet VTOL and STOL airplanes with a corresponding conventional jet transport are presented in Table 4. They indicate that, in the case of jet airplanes, either VTOL or STOL involve large increases in gross weight, power, and fuel used.

Which Configuration?

From this study, it quickly became apparent to the analysts that the helicopter would be the best machine for operations up to about 100 miles because it is primarily designed for operations where speed is not important and hovering ability represents its greatest asset. The propeller V/STOL aircraft seem to cover the range from 300 to 800 miles more efficiently than any of the other vehicles considered and would probably be a tilt-wing configuration with a large-chord flap. The figures listed for the jet STOL and jet VTOL indicated that, at the present state of the art, jet VTOL and STOL aircraft are not very attractive. There is, however, a possibility, that was not explored in this analysis, of obtaining modest reductions in landing distance (and perhaps also take-off distance) for only slightly overpowered jet transports by using the jet-flap principle.

The matter of traffic density brings some interesting factors into the VTOL picture, for if we assume that these vehicles will replace the current short-haul fleet, this would mean some 25 gates about 160 ft apart at large airports. If these were placed in a circle, we would have a diameter of some 1600 ft. If we are optimistic and assume that the VTOL machine would require only 400 ft of ground space for terrain clearance such as over the 50-ft obstacle, and if we realize that these machines are about 100 ft long, and if we allow space for taxiing, turning, and parking these aircraft, at least as much space as this 1600-ft circle would have to be provided for ground handling of the vehicle. Furthermore, if one considers parking areas and terminal facilities such as 25 or 30 gates, one will find that the ground facilities for such an airport would probably occupy more space than the area required for the VTOL aircraft operation and handling except for very low-density areas. On this basis, then, it becomes obvious that one might as well utilize the greater efficiency and safety of the V/STOL airplane with some ground run being used as common practice rather than to insist on having a hovering aircraft in every case. On this basis, then, we again come to the conclusion that the V/STOL airplane would be a next logical development.

Fig. 7 Power-speed curves for the propeller-driven V/STOL transport. For safety, take-off would be at about 30 knots, and the amount of power required would drop rapidly with increase in speed.



The power requirements of the V/STOL airplane are illustrated best by the power-required curve shown in Fig. 7, which indicates that these aircraft would take off at about 30 knots and that the power required would drop very rapidly as speed increased. Thus, if the pilot made his take-off with a lift-off at 30 knots, there is only a very short time before the power required would drop to the point where he could fly out on about $^1/_4$ of the installed power put in the vehicle to provide a potential hovering case.

Wind Damage

The high-velocity slipstreams of the VTOL and STOL airplanes might constitute a serious problem. These slipstream velocities during climb-out and approach must be considered in providing sufficient clearway around the VTOL/STOL airport. Velocities on the ground below the aircraft outside the clearway should probably be less than 50 mph. From some analyses and experimental studies done at Langley it would appear that downwash velocities of 50 mph could be experienecd at distances up to about 160 ft below propeller-driven VTOL and STOL transports during the low-speed operations. Since high jet velocities attenuate much faster, roughly the same type of figures would hold for the jet VTOL transport for the case where the lifting engine is utilized.

A Ten-Year Project

It appears from the work that has been done in the wind tunnels, with the test beds, and by the various companies, that a competitive propeller-driven V/STOL aircraft could be built, possibly for service in about 10 years. There would, of course, be the normal type of development problems associated with bringing any new system into use. The work of the various groups on handling qualities has told us, however, what is required in the way of satisfactory handling qualities and that techniques are available to provide them if we want to. The propulsion systems also seem to be generally in hand. Turbine engines are already available that would require only minor modifications for use in small V/STOL transports; and experience has already been obtained with large propellers such as those required for these aircraft.

FRESH Water from SALT Water

Industry will not need to be tethered to any location because of water supply, if it utilizes saline-water conversion in combination with its other processes

By Allen Cywin, Mem. ASME
Office of Saline Water, U. S. Department of the Interior, Washington, D. C.

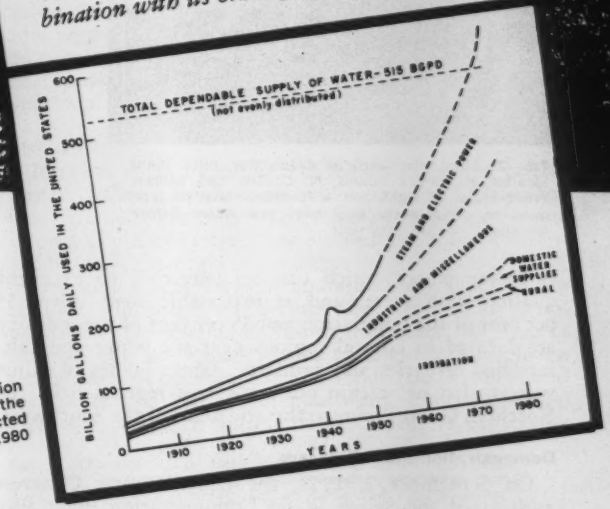


Fig. 1 Water consumption and estimated demand in the United States projected to the year 1980

EXPANDING POPULATION, industrial growth, and increased irrigation have all brought about a steep upward trend in the use of water, Fig. 1. The Hoover Commission on Water Resources has stated that "competition is keen and in some areas critical." The better aquifers have been tapped and dams have already been placed on the best river sites. New aqueducts have to reach much farther to marginal river sites and at costs that far exceed those of the 1940's and earlier.

The author is Assistant Director of Demonstration Plants.

Contributed by the Process Industries Division and presented at the Summer Annual Meeting, Dallas, Texas, June 5–9, 1960, of THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS. Condensed from Paper No. 60—SA-24, originally entitled "Saline-Water Conversion and the Demonstration Plant Program."

Of primary importance to the engineering profession is industrial fresh water, the demand for which will be 400 per cent greater in 1980 than in 1955. About 80 per cent of all major industrial-water requirements (over 20 million gal per yr per user) comes from company-developed sources, the remaining 20 per cent from municipal water systems. It is therefore important for all engineers to understand water problems and to appreciate the various alternative solutions. By 1980 the predicted demand for fresh water (597 billion gpd) will exceed the dependable available natural waters (515 billion gpd). If our economy is not to falter, saline-water conversion will have to receive increased attention.

Fortunately, the United States has an unlimited supply

FRESH Water from SALT Water

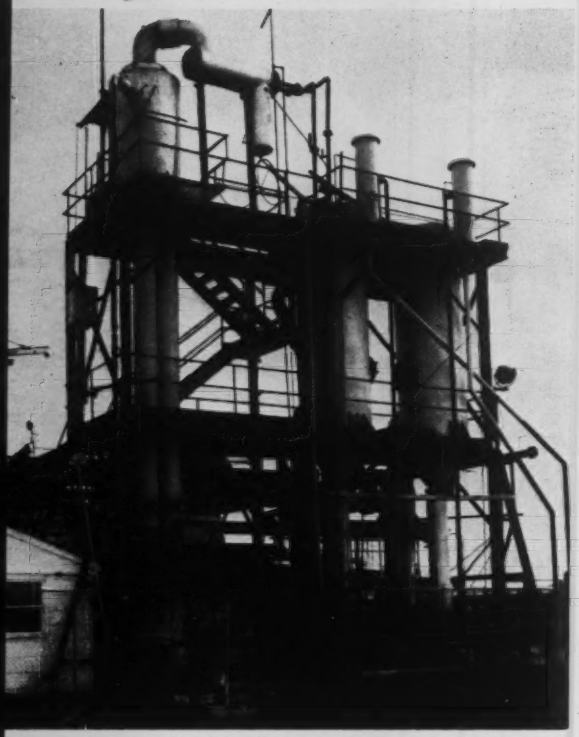


Fig. 2 Long-tube vertical evaporator pilot plant located at Harbor Island, N. C. The two shorter evaporators, at right, are a forced-circulation type used to concentrate and heat sea water before feeding it to the test unit.

of saline water which can be converted to excellent quality fresh water and at reasonable cost. Over 55 per cent of the population and 65 per cent of the industry are located in coastal regions near sea water and salt-intruded estuaries and aquifers. Great bodies of saline waters also lie within our most arid regions from the Northern Great Plains to the arid areas of the Southwest.

Demonstration-Plant Program

On September 2, 1958, the United States Congress authorized the Saline Water Demonstration Plant Program[2] to "demonstrate with the least possible delay in actual production tests the several optimum aspects of the construction, operation, and maintenance of sea-water conversion and brackish-water treatment plants." The Act further provides for the construction of at least five such plants, each to be of a different process, and each to be in a different geographic location. Nearly 200 communities near sources of saline water have applied for one of these five small demonstration plants.

Many process ideas have also been suggested. Five of the most advanced have been selected to date for process demonstration: Multiple-effect long-tube vertical, LTV; multistage flash distillation, MF; an electrodialysis system; forced-circulation vapor compression, FC-VC; and freezing. Each process has low-cost conversion potential and has been studied extensively through the Office of Saline Water in co-operation with private industry.

Long-Tube Vertical

The long-tube vertical type of evaporator, LTV, has been used for many years, primarily in the liquor-concentrating processes where crystallization is not involved, such as in concentrating waste sulfite liquors in the pulp industry. It represents one of the cheapest forms of heat-transfer surface per dollar of installed cost and per unit of energy required for operation.

The LTV multiple-effect system operates thermodynamically in a manner similar to the old submerged-tube evaporators found on most large ocean ships and in some power plants today. Several boiling chambers or effects are used. In the highest-temperature effect, preheated water is evaporated at a given pressure. The water vapor flows to a second compartment (by ΔP), condenses and transfers its latent heat to the incoming feedwater on the opposite side of the heat-transfer surface, thus vaporizing an equal amount of sea water. The new vapor in turn flows to another compartment, or effect, kept at lower boiling pressure, and the condensing-boiling process is repeated.

The potentials of this, as well as other evaporation processes, depend upon: (*a*) Scale control, (*b*) inexpensive heat-transfer surfaces (corrosion prevention), and (*c*) degassing of noncondensibles which directly affects (*a*) and (*b*). A layer of $CaSO_4$[3] scale, for example, only 0.01 in. thick would cause a 25 per cent reduction in capacity for a heat-transfer surface designed for 600 Btu per hr per sq ft per deg F. One per cent of gas in the steam has the same effect as the 0.01 in. of scale. Degassing is easily solved but scale and corrosion are traditional limitations.

There are three principal types of sea-water evaporator scale $CaCO_3$, $Mg(OH)_2$, $CaSO_4$. In pilot-plant operations at Wrightsville Beach, N. C., acid-injection pH control and internal sludge stabilization have successfully prevented scale. Acid injection is quite simple and effective to about 212 F, but it requires corrosion-resistant alloys and involves the expense of feed treatment.

Internal sludge stabilization, tested successfully up to 250 F, represents a breakthrough for sea-water conversion. The higher temperatures permit a significant reduction in heat-transfer surface and specific volume, and permit the use of additional effects, thereby increasing efficiency and consequently lowering cost.

In the sludge technique, fine crystals (seeds) of the scale-forming material in suspension are introduced into the evaporating liquor, and additional scale forms on the seeds rather than on the heating surface.

Maintenance of a suspension of seed crystals in an LTV type (once-through, high-velocity) evaporator is not too difficult to accomplish. The system has been successfully tested for $CaCO_3$ and $Mg(OH)_2$ in an Office of Saline Water pilot plant at Harbor Island, N. C., Fig. 2. Cost estimates show that, as plant size increases, the costs decrease sharply.

The LTV sea-water demonstration plant, to be located at Freeport, Texas, is designed to produce at least 1,000,000 gpd of fresh water for industrial and municipal use.

[2] This supplements the Saline Water Act of July, 1952, which provided for a modest research and development program.

[3] Actually $CaCO_3$—calcium carbonate; $Mg(OH)_2$-magnesium hydroxide; and $CaSO_4$-calcium sulfate.

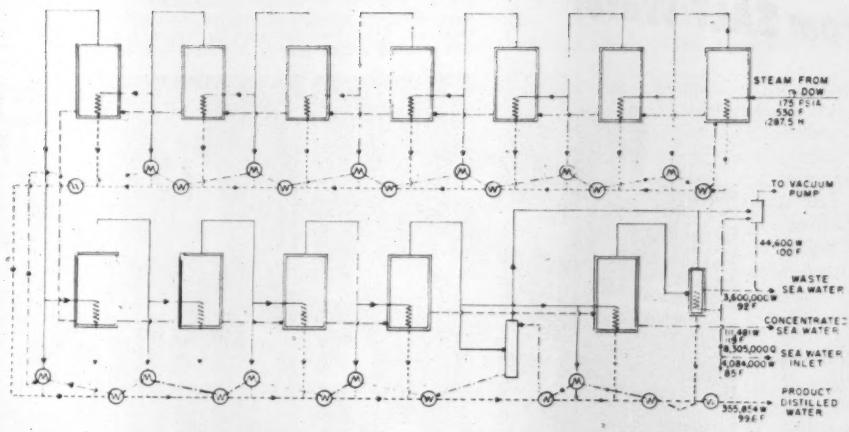


Fig. 3 Process flow sheet for the long-tube vertical demonstration plant to be built at Freeport, Texas. Half the product water will be sold to the Dow Company and half to the City of Freeport. Dow will also investigate the economic potential use of the brine effluent.

Such features as falling film evaporation at 250 F, 12-effects efficiency, and internal-sludge scale control will be demonstrated and corrosion testing performed, Fig. 3.

Multistage Flash Distillation

The second 1,000,000-gpd sea-water demonstration plant will utilize the multistage flash sea-water evaporator process which has received increased commercial attention during the past five years. Unlike other evaporator processes, saline water is heated at a pressure above the boiling point of water and vaporization does not take place at the heat-transfer surface.

After being heated, the saline water is introduced into a region where the absolute pressure is artificially maintained below the equilibrium vapor pressure corresponding to the temperature at which the water enters. As a result, a portion of water evaporates in an attempt to restore equilibrium. The energy for evaporation comes at the expense of the entering liquid, which therefore drops in temperature.

If a condenser is added to this system, the vapor produced, as it liquefies, heats the feedwater passing through the tubes of the condenser. This process of flashing a fraction of the feed liquor and condensing the vapor produced may be combined in many stages in series as shown in Fig. 4, eliminating intermediate pumps and heat exchangers.

The multistage flash process permits large evaporator units to be designed with higher efficiency than the older commercial types, at decreased capital investment. In addition, present practice calls for the operation of these plants at less than atmospheric boiling temperature and with chemical feed treatments, such as Hagevap,[4] to insure against scaling. Cheaper combination LTV-MF cycles may be possible and sludge stabilization may also be adaptable to the flash process to permit higher temperatures.

The demonstration plant, to be located at Point Loma in San Diego, will permit flexible use of a large number of stages; operate at 200 F at design temperature with the capability of operating at higher temperatures (dependent on new scale-control techniques); incorporate corrosion tests; and permit future expansion. It is designed to utilize energy from a new type of nuclear reactor designed exclusively for process-steam production.

A conversion process of any type will require large amounts of energy, usually in the form of low-pressure steam. A 50-million-gpd flash evaporator will require approximately 400 tmw, for example. In areas of restricted fuel supply, such as southern California or Florida, this might well cause an increase in fuel costs and in turn add to the cost of converted water. Certain proposed large diversion projects will also create pumping demands that will be difficult to meet economically with available fossil-fuel supplies.

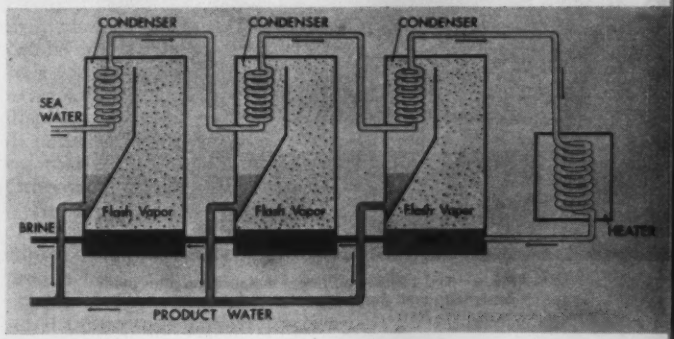
Especially designed base-load process-steam reactors using aluminum or steel-clad elements and operating at low pressure levels (150 psig), which appear to be more economical than present types of power reactors, may thus prove more economical in certain areas than conventional low-pressure steam generators.

Electrodialysis

In recent years a great deal of research has been carried out on different methods of converting brackish water. One method utilizing ion-exchange membranes and known as electrodialysis has reached the stage where it can be classed as a practical process.

Envision a compartment containing an anode and a cathode which is divided into three sections by semipermeable membranes. Passing an electric current through this cell causes anions to migrate through the semipermeable membrane to the anode compartment and cations to the cathode compartment. In this simple form the process is inefficient as current is carried by

Fig. 4 The multistage flash-distillation cycle permits large evaporator units to be designed with higher efficiency than the older commercial types, but at decreased capital investment for comparable capacity



[4] Hagevap is a commercial blend of a polyphosphate and antifoam compound.

FRESH Water from SALT Water

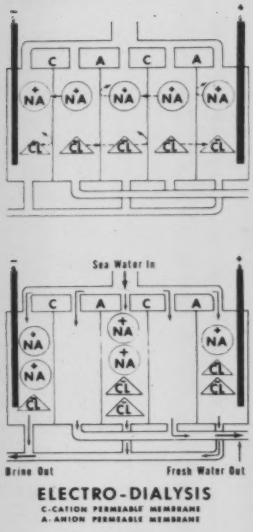


Fig. 5 Close-up view of a typical electrodialysis stack showing membranes clamped in a horizontal position. Some variations of this process place membranes in a vertical position.

Fig. 6 The first municipal saline-water-conversion plant in the United States is located at Coalinga, Calif. Manufactured by Ionics, Inc., it will produce 28,000 gpd of demineralized water.

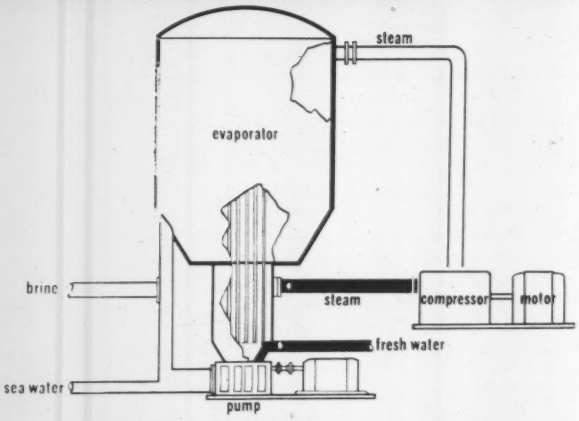


Fig. 7 In the forced-circulation vapor-compression distillation plant the salt-water feed is preheated in an approach heat exchanger, then brought to its boiling point under pressure. Released to a flash chamber, a small portion vaporizes and a part of the feed is recirculated.

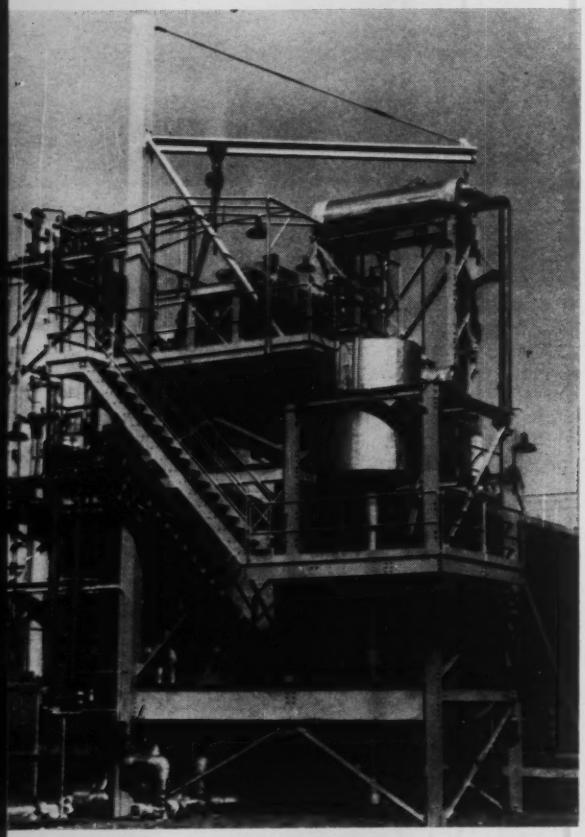


Fig. 8 The 15,000-gpd freeze-evaporation pilot plant designed and built by the Carrier Corporation, Syracuse, N. Y.

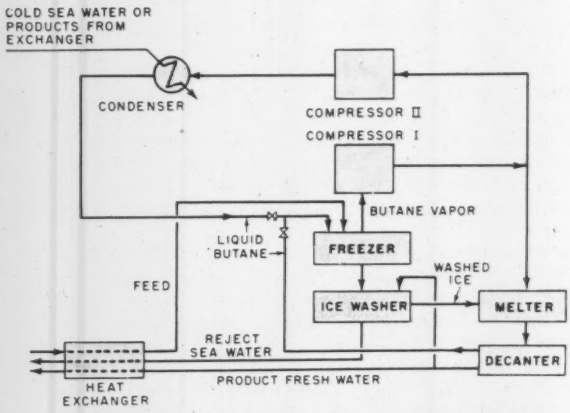


Fig. 9 A pilot plant of 35,000 gpd is being built by the Blaw-Knox Company for the Office of Saline Water. It will use the direct freezing and countercurrent washing demineralizing cycle.

hydrogen ions from the anode compartment and by hydroxyl ions from the cathode compartment. This does not contribute to the desalting of the water. When additional sections are introduced, desalting takes place in the many compartments, but the effect of overvoltage remains the same in the end compartments, thereby increasing efficiency. The anode and cathode are constructed of graphite or magnetite and membranes are alternately of cation and anion-exchange materials.

There are numerous hydraulic problems in the design of a cell of this type. To keep cell resistance as low as possible, the membranes have to be close together (0.5–1 mm), while water has to be distributed into each compartment and flow uniformly over the whole of the surface of the membranes—one of the design problems which has to be surmounted, Fig. 5.

Electrical consumption is influenced by many factors, one of the most important of which is the quality of water to be produced.[5] Obviously, if very high quality water is required, the final stages of purification will bring about an appreciable increase in the resistance of the electrolyte and therefore a greater voltage will have to be applied to obtain the desired current density for purification to take place and power requirements will increase. Another important power factor is the total dissolved-solids content of the water to be treated.

As in multiple-effect distillation, the kilowatt requirements can be reduced substantially by using cells of twice the areas, thereby reducing the value for current density by 50 per cent. Conversely, the costs of the electrolytic cells can be reduced by increasing the current density, hence power costs. Since low-salinity (brackish) waters will use the least power with the least cell area, a 250,000-gpd brackish-water demonstration plant of this type will be used on waters of less than 2000 ppm at Webster, S. Dak.

One of the principal problems in electrodialysis involves the membranes themselves. There are two types —homogeneous and heterogeneous. The homogeneous membrane consists wholly of ion-exchange material, and the problem is to build in sufficient strength to give the desired mechanical properties for reasonable life. The heterogeneous membrane aims at obtaining the desired mechanical strength by reinforcing the ion-permeable membrane with such materials as woven glass or woven synthetic fibers such as Orlon. Unfortunately, membranes that have good mechanical strength and good selectivity as well as low electrical resistance are also expensive to manufacture. Considerable practical field experience will assist in the further development of the membranes, velocity of flow, and hydraulic flow paths —all of which are objectives for the demonstration plant.

Certain chemical problems are quite similar to scale-formation problems encountered with sea-water evaporators. Obviously, waste water from an electrical desalting plant cannot be concentrated to the point where saturation of any compound present in the raw water is reached. Calcium sulfate, which is sparingly soluble and present in most natural waters, imposes the limits in most cases.

There is also danger of alkali scales such as calcium carbonate and magnesium hydroxide, especially when high demineralization is required. That problem, however, can be reduced by pH control (acid injection) in similar fashion to distillation practices. Acid also has to be added to the cathode compartment where alkali scale is prone to deposit due to the release of hydroxyl ions.

Because there is insufficient field experience with this equipment (its commercial applicability is only about five years old) and present units are custom made, it is difficult to assess the total cost for this process. The water to be treated must be perfectly clean or else the necessary clarification and filtering equipment must be added to the costs. In addition, membrane life, hence replacement charges, is not determinable with accuracy. A photograph of equipment of this type installed in the first United States municipal saline-water conversion plant is shown in Fig. 6.

Forced-Circulation Vapor Compression

Thousands of small efficient vapor-compression distillers have been used by the armed services during and since World War II. In general, vapor-compression apparatus, while more complex and difficult to operate than multiple-effect systems, requires less fuel input, needs less cubic space per gallon of output, does not need large volumes of condenser water, and lends itself extremely well for use where internal-combustion engines and electric motors are the prime movers or sources of energy.

The standard vapor-compression cycle is simple. Salt water is brought to boil in a tubular heat exchanger, vaporizes in part, then is superheated through heat of compression, and condenses in the evaporator-condenser bringing an equal amount of salt water to boil once again. The cycle repeats with the distillate and brine being discharged through an approach exchanger which preheats the sea water.

The costs for this type of system may be grouped in the following categories when operating at 212 F, although this is quite difficult to maintain because of scale formation: (*a*) Evaporator-condenser, 25 per cent; (*b*) compressor, 15 per cent; (*c*) energy of compression, 40 per cent; (*d*) scale retardation and cleaning, 10 per cent; (*e*) auxiliaries, pumping, and so on, 10 per cent.

The costs of (*a*), (*b*), and (*c*) are all dependent upon the temperatures of evaporation. The lower the temperature of evaporation, the less troublesome scale becomes. But at the same time, much larger areas of heat transfer and a large-volume compressor are needed. One method for increasing heat-transfer coefficients and also of mitigating scale formation is through the use of forced circulation of the feedwater. Dropwise condensation on the vapor side of the evaporator would also assist in increasing heat-transfer rates.

The fourth demonstration plant will be a forced-circulation vapor-compression distiller and provide for dropwise-condensation experiments if suitable promoters can be developed. In addition, the demonstration plant will use an axial-flow unit which should be much less expensive per unit of output than the usual positive-displacement compressors. Furthermore, it has been demonstrated that scale can be prevented economically by intermittent pH control and by increased blowdown. Other techniques may also be tried.

The 250,000-gpd demonstration-plant cycle to be located at Roswell, N. Mex., will generally follow that shown in Fig. 7. Salt-water feed preheated in an approach heat exchanger will be brought to its boiling point under pressure, released to a flash chamber where a small proportion vaporizes and a part of the feed is re-

[5] Recommended salinity limits are: 1000 ppm for agriculture, 500 ppm for potable water, 15 ppm for battery cells, and so on.

circulated. The vapor is compressed and condenses, releasing latent heat to feedwater and the cycle repeats.

Freezing

Thermodynamically and from a scale and corrosion viewpoint, the freezing process has potential for a variety of saline-water conversion applications. Freezing the ice crystals (which are pure water) in a brine solution is only a part of the process problem. The ice crystals must then be separated from the brine.[6] The crystal shape and size, together with the viscosity of the adhering brine at the low temperatures involved, make separation very difficult economically.

The most economical solution to separation to date appears to be countercurrent washing of the ice crystals using a portion of the purified water. It has been possible to produce converted sea water to less than 500 ppm using approximately 5 to 10 per cent net wash water by the wash method.

There are at present two leading methods for economically producing sea-water ice—freezee vaporation, and direct cooling. The very first freezing saline-water-conversion pilot plant of any appreciable size, Fig. 8, has been designed and is under test by the Carrier Corporation. Sea water is introduced into a high-vacuum chamber and flash cools to a temperature low enough to produce ice crystals. Water vapor is an additional source of purified water and is either mechanically compressed for condensation or handled by absorption units.

In the other leading freezing process, a refrigerant such as isobutane is introduced directly into the brine thus freezing some of the solution into ice crystals. The use of a direct refrigerant greatly reduces the size of compressor needed as compared to the other cycle but adds the complication of handling a second fluid with little or no loss allowed. A pilot plant of 35,000 gpd is being designed by the Blaw-Knox Company for the Office of Saline Water, Fig. 9.

Although the development of freezing processes is not far enough along to make firm cost estimates, it appears that either of these two methods shows promise for producing demineralized water at 50¢ to $1 per thousand gallons in plants of very large size. Design will start in fiscal 1961 on a true pilot plant designed to advance a freezing process to its commercial prototype phase.

By-Products

Combination Power Plants. The most promising method of saline-water conversion is in combination with steam-generated electric power. The proposed distillation plants could either receive high-pressure steam (from a modern efficient boiler) that has been expanded through a thermo-compressor, used for several of the evaporator effects, or steam expanded through a back-pressure turbine, producing power. In a power-plant combination, most of the cost of fuel and steam production is chargeable to kilowatt sales, permitting the use of low-pressure-turbine extraction steam, Table 1.

Engineering, construction, and operating costs can also be pooled. Freezing processes using absorption or compression systems are also readily adaptable to combination plants. It is significant that several of the new large sea-water conversion plants—in Aruba, Curacao, and Nassau—are combination power-water plants.

Table 1 Summary of Unit Cost of Steam and Power

Operating time	Fuel cost, cents per million Btu	Steam temperature, deg F 140	160	180	200	220
		Steam cost, cents per 1000 lb				
7920 Hours annually	20	2.4	5.6	8.8	13.8	15.0
	30	3.4	7.6	11.2	14.6	18.8
	40	4.4	9.3	13.6	17.6	22.4
	50	5.6	11.1	16.1	20.7	26.1
	60	6.5	12.7	18.4	23.6	29.7
		Power cost, mills per kwhr				
7920 Hours annually	20	4.72	4.98	4.27	5.57	5.93
	30	5.87	6.21	6.55	6.92	7.43
	40	7.03	7.43	7.84	8.28	8.86
	50	8.20	8.65	9.12	9.63	10.30
	60	9.35	9.86	10.40	10.98	11.73
		Steam cost, cents per 1000 lb				
5256 Hours annually	20	2.5	6.8	10.7	14.4	19.1
	30	3.5	8.6	13.2	17.3	22.7
	40	4.6	10.5	15.6	20.5	26.5
	50	5.8	12.2	18.2	23.5	30.1
	60	6.6	14.0	19.7	26.5	33.7
		Power cost, mills per kwhr				
5256 Hours annually	20	5.93	6.27	6.63	7.02	7.58
	30	7.09	7.50	7.92	8.37	9.01
	40	8.25	8.72	9.20	9.73	11.45
	50	9.41	9.93	10.49	11.08	11.88
	60	10.56	11.16	11.71	12.43	13.32

Other Minerals. Sea water has also become a primary raw material for the commercial production of salt, bromine, magnesium, and allied products, and will be an increasingly prominent source of these and other minerals as other more concentrated sources are depleted. Combination nuclear plants deriving deuterium from the sea and producing fresh water and plutonium are other types of combination possibilities. Chemical products (such as fertilizers) may also be integrated.

Summary and Conclusions

The increasing water problem is of the utmost importance to the engineer in industry who is responsible for seeing that his plant and its processes are supplied with ample amounts of good quality fresh water, as well as to the waterworks engineer.

Five different saline-water-conversion processes are to be demonstrated in experimental plants to be constructed by the United States Government in five different geographical regions. The first three should be in production by July, 1961, and the last two by July, 1962.

Saline-water plants have a potential for producing potable water at approximately 50 cents per 1000 gal, less with power and other by-product combinations. Although only in its technical infancy, saline-water conversion is becoming practical and economical for civilian applications.

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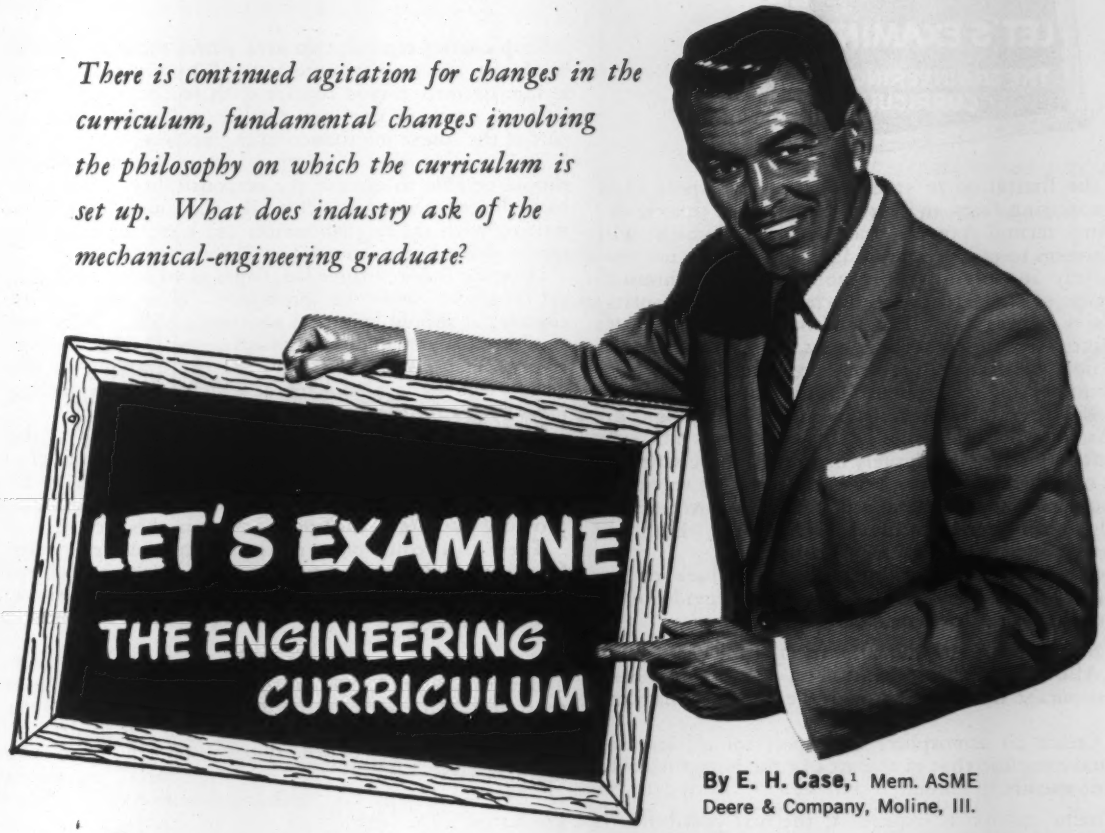
[6] The crystals are small and flat and approximately 0.1 to 0.4 mm in length and width by 0.01 to 0.08 mm in depth.

There is continued agitation for changes in the curriculum, fundamental changes involving the philosophy on which the curriculum is set up. What does industry ask of the mechanical-engineering graduate?



By E. H. Case,[1] Mem. ASME
Deere & Company, Moline, Ill.

THE present mechanical-engineering curriculum is designed to provide a broad technical background of basic fundamentals. For the main part it has resisted specialization and dilution to a remarkable degree. Its graduates have been sufficiently well grounded in basic fundamentals to adapt themselves to a wide variety of assignments, and it probably comes the nearest to being a universal engineering curriculum. Several specialized curriculums have evolved from mechanical engineering, but for the main part this curriculum has remained one of broad basic fundamentals.

Why are we so disturbed and anxious to change this concept? Why is it necessary today to feel that we should emphasize the humanities at the expense of basic technical subjects, or train scientists instead of engineers? Why not be flexible and modernize this mechanical-engineering curriculum as needed but retain its concept of basic fundamentals, design, and analytical skills that so readily permit the student to adapt himself to a wide variety of technical problems?

Sciences and Humanities

In a broad sense, it appears that the subject of mechanical-engineering curriculum planning lends itself to consideration and study on two fronts—namely, the humanities and the sciences.

For the past several years much has been said and written about the future of the liberal-arts graduate. His qualities and leadership are extolled as being superior. He is considered to be a "well-rounded individual" who has great strength for the world of tomorrow because he has the ability and capacity to grasp large problems and provide solutions.

When we consider the pace of technical developments in the world we live in and what the future is already unfolding before us, a better case could be made for adding technical courses to the liberal-arts curriculum than for the further dilution of the engineering curriculum. Liberal-arts graduates of tomorrow may well find that the road to leadership is difficult if they are uneducated technically. Engineering educators have not been blind to the importance of the liberal arts and the necessity of making a reasonable compromise. They have recognized that this is not a matter of all one or all the other. Students in both areas are people. The aptitudes and interest may vary, but the factors that lead to success and productive careers are probably equally divided between the professional and non-professional students.

No curriculum yet devised can guarantee success—it is the individual who attains it.

The Educated Man

It is said that an educated man has learned how to entertain himself, to entertain a friend, and to entertain an idea. Unless our goal is to train skilled technicians, our engineering graduates must be educated and not

[1] Director, College and University Relations.

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have the limitation of students who have spent their time acquiring facts and inert terms rather than in developing mental powers and discipline which will enable them to master knowledge and put it to use constructively in solving the problems of man himself. This type of student has too much respect for quantitative facts and, as a result, a tendency to think and act in quantitative terms. There must also be an awareness that nonquantitative problems must be solved, and mathematics and science must look to history, philosophy, and literature for assistance in making judgments in this area of intangibles. This concept is most important as we live in a largely nonquantitative world.

We cannot afford to neglect or pay only lip service to the nonquantitative liberal-arts courses and we cannot afford to dilute the technical curriculum. Both are needed.

Three possibilities for broadening the base of the mechanical-engineering curriculum to provide more time to the humanities come to mind:

1 Streamline the technical portion of the curriculum.
2 Allow for more acceleration on an individual basis and encourage this acceleration in the area of the humanities.
3 Create an atmosphere of respect for all learning and make it clear that in the area of the humanities the student must help himself.

Extreme caution is required if the first possibility is selected and it is doubtful if its implementation on a broad scale can be recommended.

There is a distinction between a scientist and an engineer in aptitudes, philosophy, and motivation. In a crude sense it is the difference between theory and the utilization of theory to practical applications of immediate value. It will be a relatively rare individual who can be equally proficient in both.

Here is needed a clean-cut decision. In the short space of four years the education of an engineer can be started or the education of a scientist can be started. It is doubtful if both can be done adequately with one curriculum in the same period of time.

Hiring a Graduate

Many factors go into the selection of mechanical-engineering graduates for positions on our staff. No doubt these factors vary from corporation to corporation, but in our case we place an emphasis on the ability to learn. This ability to learn permits the young employee to adapt himself to a wide variety of problems if he has a firm foundation in basic fundamentals and analytical ability. We have few specialists, and responsibilities come early in a man's career. Our designs are complex, our products are sold on a very competitive and, in addition, seasonal market.

For our engineers this means technical competence, judgment, flexibility, and speed. The mechanical-engineering graduate with a shallow footing of fundamentals or a weakness in analytical ability will not develop or advance in this atmosphere unless he is willing and able to go to considerable extra effort.

Shop courses represent an area where industry should be able to stand on its own feet. Why not teach them as familiarization-type courses with teacher demonstration, or even go one step further and teach them as part of the course in production engineering?

Technical writing is another area in which industry should be able to assume the responsibility. Why not have the engineering students take the course in creative writing with the English majors and leave the details of report writing up to the industrial training program?

Drawing is one of three languages in which a mechanical engineer must be proficient. However, for an engineer it should be a tool and not a skill. Why not combine a course in drawing fundamentals with descriptive geometry and then carry on the drawing in the design courses as a tool for developing and expanding ideas by graphical means?

Costs are an integral part of engineering work as the best-designed product has limited value if it cannot be produced and sold competitively. There is much to be said for the inclusion of a course in economics that provides training in the fundamentals in this area.

There is a requirement in the machine-design course for more emphasis on design projects to teach problem analysis and provide solutions to complete situations. It would be helpful if layout techniques could be touched on.

Considerable emphasis is now placed on thermodynamics. Would it be practical to offer a single concentrated basic course in thermodynamics and teach the advanced material in the course in which it is used?

There is reason to believe that an opportunity to take mathematical courses beyond differential equations would be helpful to mechanical-engineering undergraduates. The increasing use of computers as an engineering tool is one of the factors bringing this consideration to the fore.

Although it is probably no longer possible to do it, mechanical engineers would profit if they could take the same basic electrical courses as the electrical engineers.

Would it be practical to encourage the better students to prepare for specialization in the field of their choice by taking courses in excess of the normal college load? This same practice could also be encouraged in the humanities.

A Practical, Confident Engineer

This is not a time for educators to be defensive or hesitant. Also, this is not a time for rigidity and standardization in curriculum planning. Technical advances and concepts are not something that took place last year—they probably took place this morning, or will this afternoon. With due consideration for the humanities and broad coverage in engineering sciences, the basic consideration in curriculum planning should be the training of a practical, confident engineer. Whatever the changes in the curriculum may be, they will not be able to make a dullard into a genius, they will not be a miraculous catalyst for every student, nor will they satisfy all employers. No curriculum yet devised can guarantee success—it is the individual who attains it.

The important things are motivation, technical competence, adaptability, ability to learn, and ability to handle people. One course more or less in the curriculum will probably not have an appreciable effect over a productive career.

These new materials will go into radomes and such applications as precision gages and machine-tool-parts whose dimensions must not change with temperature

GLASS-CERAMICS

By S. D. Stookey, Manager of Fundamental Chemical Research, Corning Glass Works, Corning, N. Y.

Can you picture glass-ceramic bearings, running without lubrication?

In May, 1957, the author's company announced the discovery of a family of fine-grained crystalline materials, called glass-ceramics, made from glass by a new process of controlled crystallization. Products made from them are trade-marked Pyroceram.

In the three years since their discovery, the materials first put into production have developed large-scale applications. They give promise of finding increasing uses as engineering and structural materials in the future as new compositions are developed and further improvement of properties continues.

Several factors combine to give glass-ceramics special value as engineering materials. They have unique advantages over most ceramics and glass: (*a*) An almost ideal microstructure; fine-grained, uniform, and free from voids or flaws; (*b*) the capability of being "tailor-made" to have various useful combinations of properties, by variations in composition and processing; and (*c*) low cost, versatile forming methods.

Manufacturing Process

Melting. The batch ingredients for making glass-ceramics, including the nucleating agent, are mixed and melted to a homogeneous molten glass. Depending on the composition, the glass may be nearly as fluid as molten metal or extremely viscous. The glass is held extremely uniform in composition, by stirring and other methods, just as optical glass is made.

Forming. The molten glass is formed by conventional glass-forming methods, such as pressing or blowing into molds; drawing as tube, rod, or pipe; rolling or drawing into flat sheet; or centrifugal casting. The more fluid glasses may be cast into intricate shapes by methods similar to metal casting. Sizes and shapes that can be made are virtually without limit.

After casting, the glassware is cooled. At this point, it is transparent and readily inspected for flaws or bubbles. Some compositions can be reheated and reworked into new shapes while still in the glassy state.

Heat-Treatment. A generalized diagram, Fig. 1, shows the essential features of the thermal treatment of a glass-ceramic. After the glass has been melted to a clear homogeneous liquid at T_m, and formed to shape, it is cooled to the nucleation temperature T_n (or cooled to room temperature and later reheated to T_n). Holding at this temperature causes precipitation of an enormous number of uniformly dispersed subcolloidal crystal nuclei having a composition different from the major crystal phases. Subsequent heating to the growth temperature T_g initiates growth of crystals of the major phase or phases on these nuclei. Holding at this temperature converts the glass article, substantially unchanged in size or shape, to the fine-grained crystalline product Pyroceram. The crystals in Pyroceram are normally smaller than 0.0001 in. diam., and are randomly oriented.

Finishing. Although it is possible to reproducibly form glass-ceramic articles to reasonably close tolerances without further finishing, some high-precision shapes do require finishing. Glass-ceramics can be ground and polished to very accurate dimensions by the methods used for glasses, ceramics, and hard metals.

Microstructure

With certain types of heat-treatment, the glass-ceramic may be crystallized completely and uniformly with crys-

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GLASS-CERAMICS

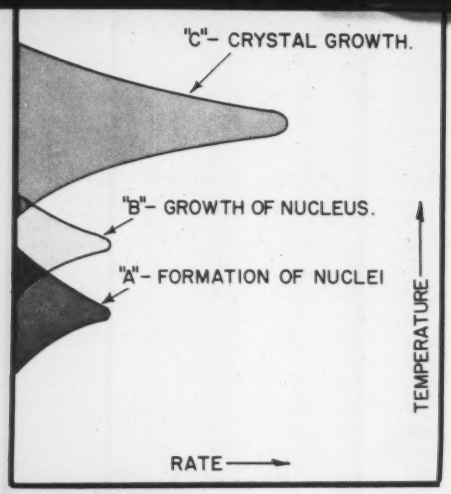

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Fig. 1 Schematic graphs of the rates of nucleation and crystal growth as functions of temperature in glass-ceramics

Fig. 2 Here a very thin flake of glass may be seen before its conversion to glass-ceramic. Flakes have the structureless nature characteristic of glass. Electron transmission micrograph, 157,000×. (The transmission electron miscroscope produces an image analogous to a monochromatic light image in which details are made visible through variations in intensity. Only thin specimens can be examined by transmitted electrons.)

Fig. 3 The same glass after nucleation at 720 C shows a high concentration of particles (nuclei) with diameters of approximately 30 A. Nucleation at higher temperatures and shorter times produces fewer and larger nuclei. Electron transmission micrograph, 157,000×.

Fig. 4 The same glass after further heating for 15 min at 1050 C shows a reduction in the number of particles and an increase in their size. Electron transmission micrograph, 157,000×.

Fig. 5 After the matured glass-ceramic has been crystallized by further heat-treatment for 2 hr, the crystals are about ½ to 1 micron in diam. This is a fractured surface subsequently etched for 2 min in ½ wt per cent hydrofluoric acid in aqueous solution. The replica was made with carbon, shadowed with platinum. White spots are artifacts. Electron replica micrograph, 18,400×. (Because of the limitation of electron transmission micrographs to thin specimens, a "replica technique" was used here. An extremely thin and accurate cast, or "replica," of the surface replaced the original specimen for examination in the electron microscope.)

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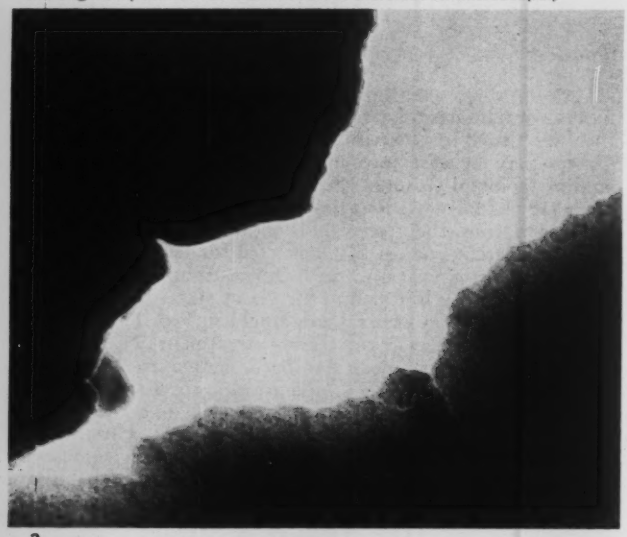

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tal diameters of less than 0.000001 in., as shown by electron microscopy and x-ray-diffraction measurements. The crystals appear first as spherical particles, and with further heat-treatment may recrystallize to angular intergrown forms, ranging up to 0.0001 in. diam. The crystal habits vary with the compositions of the crystal phases.

Microstructure and crystal composition of a given glass-ceramic are influenced by concentration and composition of the nucleating agent, and also by heat-treatment.

The crystal size of even the completely crystallized material is near or beyond the limit of resolution of the optical microscope and the structure must be investigated by such tools as the electron microscope and x-ray diffraction. In the early stages of nucleation, particles containing only a few atoms are involved and even the electron microscope is inadequate.

The stages of conversion of an amorphous glass to a typical glass-ceramic by heat-treatment are illustrated, Figs. 2–5, showing the formation of submicroscopic nuclei, their growth, and coalescence into larger crystals, and the microstructure of the matured glass-ceramic. An RCA EMU-3B electron microscope was used. The crystal size even in the matured ceramic is smaller and more uniform than that of conventional ceramics and of metals and is free from voids and from any preferred orientation. The major crystal phase in this material is a lithium aluminum silicate, $Li_2Al_2Si_6O_{16}$.

Theory of Controlled Crystallization[1,2]

When a molten metal or a molten salt is cooled below its liquidus temperature it crystallizes almost instantly, the crystallization being nucleated at cold surfaces and at the surfaces of foreign particles in the melt. This leads to a variety of grain sizes throughout a casting, also to voids and imperfections. Fortunately, it is possible to recrystallize the metal by controlled heat-treatments and mechanical "cold-working" techniques.

It has recently been discovered that the failure of glass to crystallize on cooling is due mainly to absence of crystal nuclei as well as to the rapid increase of viscosity as the melt cools.

Techniques have been developed for artifically forming submicroscopic nuclei within the article after the glass has cooled, thereby permitting controlled crystallization to occur as the glass is reheated.

The general theory of this process in a glass-ceramic is that crystallization of an undercooled melt takes place in two successive stages—nucleation and crystal growth. When the glass is cooled from above the liquidus of its major crystal phase, it goes through a temperature range (see crystal growth-rate curve C, Fig. 1) in which crystals would be able to grow if nucleation had occurred previously. The crystal growth-rate curve reaches a maximum, then decreases to zero with further cooling because of the enormous increase in viscosity. When the glass contains no nuclei, cooling through the "growth" range does not result in crystallization.

With still further cooling, a low-temperature range is reached in which nucleation and crystal growth of a minor phase—the "nucleating agent"—can occur (curves A and B). This takes place at a temperature below the crystal-growth range of the major phase, so that formation of the foreign particles occurs prior to, and independently of, crystallization of the major phase.

If the glass is then cooled and/or reheated to the nucleation range, and held for an appropriate length of time, then reheated to the crystal-growth range of temperature, each nucleus formed in the nucleating temperature range becomes the center of growth for a crystal of the major phase. By controlling the heating cycle it therefore is possible to control both the number of crystals and their size.

Properties

Glass-ceramics are nonporous and generally have an opaque white appearance in the finished state, although some compositions may also be transparent. They are resistant to high temperatures in terms both of strength and oxidation. They are like glasses in their ability to resist chemical attack with measured durabilities in weight loss ranging in values comparable to the durable chemical glasses. They are lighter and harder than most metals. In thermal conductivity they are classed as heat insulators. The thermal-expansion coefficients range from negative values, through zero, to positive values of 110×10^{-7} per deg C. Extreme heat-shock resistance and dimensional stability with temperature may be had by choice of composition to provide coefficients of expansion near zero.

In electrical properties most glass-ceramics are classed as electrical insulators having dielectric constants from 5 to 10 and power factors at high frequencies ranging down to extremely low values. In mechanical properties these materials are generally higher in Young's modulus than glasses, ranging from 12.5 to some 20 $\times 10^6$ psi with strengths higher than glasses and most ceramics, Table 1. Glass-ceramics are not ductile or

Table 1 Properties of Pyroceram

	Glass-ceramic, Pyroceram		Code 7900 96% silica glass	Code 7740 boro-silicate glass	Ceramic high-purity aluminas
General	9606	9608			
Specific gravity (at 77 F)	2.60	2.50	2.18	2.23	3.6
Water absorption, per cent	0.00	0.00	0.00	0.00	0.00
Porosity (gas permeability)	gas-tight	gas-tight	gas-tight	gas-tight	gas-tight
Thermal					
Softening temp, deg F	2282	2282	2732	1508	3092
Specific heat (at 77 F)	0.185	0.190	0.178	0.186	0.181
Mean specific heat (77 to 572 F)	0.230	0.235	0.224	0.233	0.241
Thermal conductivity at 77 F mean temp (Btu per hr)(ft)(deg F)	2.10	1.13	...	0.626	1.25–1.40
Linear coef of thermal expansion (77 to 572 F) $\times 10^7$	31.6	3.9–11.1[b]	4.45	17.8	40.5[a] (68 to 932 F)
Mechanical					
Modulus of elasticity, psi $\times 10^6$	17.3	12.5	9.6	9.5	40
Poisson's ratio	0.245	0.25	0.17	0.20	0.32
Modulus of rupture (abraded), psi $\times 10^3$	20	16–23	5–9	6.0	40–50[c]
Hardness					
Knoop 100 gm	698	703	532	481	1880
500 gm	619	588	477	442	1530

[a] In this case, 68 to 932 F.
[b] Depending on heat-treatment.
[c] Unabraded values.

[1] S. D. Stookey, "Catalyzed Crystallization of Glass in Theory and Practice," *Industrial and Engineering Chemistry*, vol. 51, July, 1959, p. 805.
[2] S. D. Stookey, "Catalyzed Crystallization of Glass in Theory and Practice," Glastechnische Berichte, Sonderband, V Internationaler Glaskongresz, 32K (1959), Heft V, S.V/1-V/8, Verlag der Deutschen Glastechnischen Gesellschaft, Frankfurt am Main, Germany.

Table 2 Pyroceram Journal-Bearing Tests (1/2-in. bore)

No lubrication, speed 540 rpm, load 27.6 lb, time 30 min

Shaft	Temp, deg F	Coef of friction
Hastelloy C	1800 to room	0.5–0.6[a]
Stellite Star J	1600 to room	0.2–0.3
Stainless 304	1600 to room	0.2–0.25
Tool steel	1100 to room	0.2–0.23
Inconel X	1800 to room	Bearing seized[b]

[a] Hastelloy C run against itself seized under same conditions.
[b] Inconel X run against itself seized under same conditions.

Table 3 Thrust-Bearing Load Tests

Three steel balls were driven against Pyroceram plate, lubricated, at 250 rpm, 25 C

Pyroceram plate	Steel plate	Pyroceram plate	Hertz mean compr. stress, psi
30 min at 2 in. Hg	30 min at 2 in. Hg	2 hr at 2 in. Hg	...
30 min at 4 in. Hg	30 min at 4 in. Hg	2 hr at 4 in. Hg	270,000
30 min at 6 in. Hg	30 min at 6 in. Hg	2 hr at 6 in. Hg	320.000
	30 min at 8 in. Hg	2 hr at 8 in. Hg	360.000
30 min at 10 in. Hg	30 min at 10 in. Hg	9 min at 10 in. Hg	380,000
Plate spalled at 10 in.	Pronounced track at 10 in.	Plate spalled at 10 in.	

malleable as are most metals, but are classed as brittle materials.

Various compositions can be tailor-made to meet desired properties, with the final control depending on special heat-treatment. Two compositions, Code 9606 and 9608, in various forms and types of product are now available commercially. Their properties are listed in Table 1 together with values for two commercial glasses and high-purity alumina for comparison.

Code 9606 is suitable for high-temperature, high-frequency applications in the electronics field. The maximum usable temperature under load is 1560 F for 1000 hr. It is being successfully used as a missile radome. Its hardness and ability to withstand high temperatures have made it suitable for consideration as an abrasive binder and for bearing parts.

Special glass-melting techniques are used on Code 9606 to insure uniform composition, constant density, freedom from bubbles and striations, and uniform electrical properties. It is most easily formed by gravity and centrifugal casting. With certain limitations, it can be pressed and rolled.

Code 9608 is especially useful for its low coefficient of thermal expansion, which gives it immunity to breakage by thermal shock and imparts unique dimensional stability.

Applications

One of the products of potential interest to mechanical engineers is bearings for operation at high temperatures without lubrication, or in corrosive liquids. Another is a lightweight, dimensionally stable honeycomb structure which has promise for use in heat regenerators for gas turbines operating at high temperatures. Still a third possibility is precision gages, and machine-tool parts whose dimensions do not change with temperature.

Bearings. In conditions of high temperature, dry (unlubricated) operation, and presence of corrosive media even the best metal bearings may perform poorly, and the metals which perform best are expensive, difficult to fabricate, and heavy.

A thorough evaluation of glass-ceramic bearings for such service is being made by a number of laboratories and bearing manufacturers. Surprisingly, glass-ceramic bearings can be finished almost as easily as steel bearings and in the same equipment.

The sliding and rolling characteristics of Pyroceram Codes 9608 and 9606 are being tested against themselves and against various metals, operating dry at up to 1800 F and also in various corrosive liquids as well as with lubricants. Although it is too early to give a conclusive report, the results are promising.

Bearing systems of various types, combining Pyroceram with such materials as Hastelloy C, Stellite 3, and titanium carbide, have been successfully operated dry at 1000 to 1800 F in some cases, under conditions that caused the best all-metal systems to seize or fail, Table 2.

The results of a test made to determine the compression load, Table 3, show that the material fails in a brittle fracture at about the same compressive stress that causes the steel to flow—about 380,000 psi.

Similarly, combinations of Pyroceram with itself and with accepted corrosion-resistant metals such as Hastelloy B or stainless steel 304, in corrosive liquids, show lower coefficients of friction, and lower wear, or lower surface damage than Hastelloy B running against itself. The liquids investigated were concentrated solutions of nitric acid, sodium hydroxide, citric acid, ferric chloride; 30 per cent hydrogen peroxide; and molten lead at 700 F.

It has been found that friction and wear of Pyroceram sliding or rolling against itself without lubrication are rather high, and that it is more satisfactory to use it in combination with certain metals.

High-Temperature Heat Exchangers. The thermal-shock resistance and the dimensional stability of the low-expansion glass-ceramics have made them useful in various kinds of heat exchangers. One interesting type has been developed for use in high-temperature turbine engines.

Dimensional-Stability Potential. As requirements for precision instruments and machines become more stringent, the gages and machine tools required to make them must become still more precise in dimensions. If these are made of relatively high-expansion metals such as steel, the dimensions vary with temperature.

The expansion coefficient of Code 9608 between 0 and 100 C is so nearly zero, when the material has been specially processed, that no measurable change in length occurs in this temperature range. For this reason, it should be a useful material for precision gages, for the beds of special machine tools, and other parts requiring constant dimensions.

Directions for Future Development

An active program is under way with the object of developing glass-ceramics maintaining strength to 2500 F and higher; increased strength, hardness, and wear resistance; tailor-made compositions having expansions to match various metals; and other useful combinations of properties.

Combinations of these materials with special methods of forming may make it possible to produce such products as heat exchangers for turbine engines, and lightweight turbine wheels for high-temperature service.

Acknowledgments

The author wishes to thank his co-workers in the Corning Glass Works Research Laboratory for their many contributions to this work, especially to Mr. Gerald Carrier for the electron micrographs.

Abstracts and Comments Based on Current Periodicals and Events

D. FREIDAY
Associate Editor

BRIEFING THE RECORD

With Skirts Yet!

CONVEYER belting with fluted skirts is being manufactured which combines the main advantages of flat belts with those of troughed belts, but in some respects is superior to either. The belting invented by G. Piemont of France is now being made in England by the Dunlop Rubber Company, Ltd., for Numec, Ltd., a subsidiary of the Derbyshire Carriage & Wagon Company, Ltd. It will be marketed in the British Isles and elsewhere.

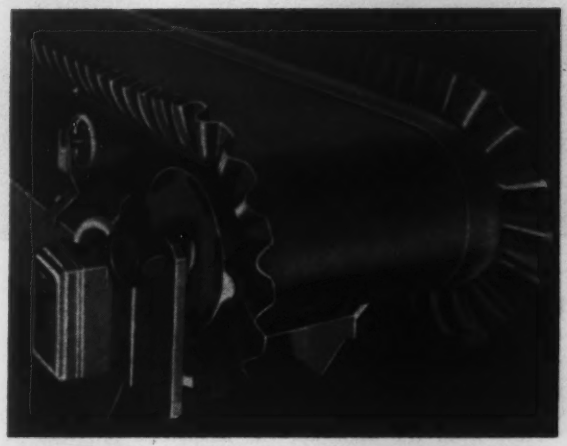
Fully covered by patents the belting runs on straight idler rollers but has a nominal carrying capacity greater than that of a troughed belt of equal over-all width. Furthermore, it is able to operate efficiently at high running speeds and can carry bulk materials up steeper inclinations than troughed belts. If integral crossbars are used, inclinations can be even steeper. There are many other unique characteristics. A Numec belt can be run on existing troughed-idler systems if Numec return idlers are fitted. And it is possible to obtain a more or less fully enclosed conveyer, somewhat akin to a zipper-type conveyer.

Full details and an evaluation of their place in the materials-handling picture are given in an article by J. M. Beskine, "Conveyor Belting With Corrugated Sides," in the August, 1960, issue of the British trade journal *Mechanical Handling*.

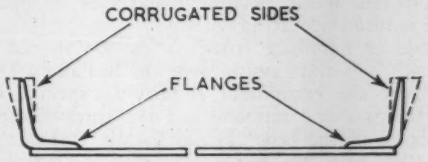
The function of the flat-belt element of a Numec belt is to carry the material being handled and to transmit the working stresses set up by traction. The corrugated sides are designed to withstand the side-pressures set up by bulk materials on a fully loaded belt and to unfold when the belt passes the end pulleys. Under side-pressure the fluted sides must not move greatly outward from their design position, which is approximately vertical. When lapping the head or tail pulleys the sides must not come under tension nor must they belly outward from the vertical position. Another requirement is that of insuring that the material being handled remains in a ribbon of constant width when leaving the belt.

Numec conveyer belts are available in widths ranging from 9 to 36 in. with 2 or 3-in-high corrugated edges, in various weights of fabric from 2-ply up. They can be obtained in any thickness or grade of rubber cover.

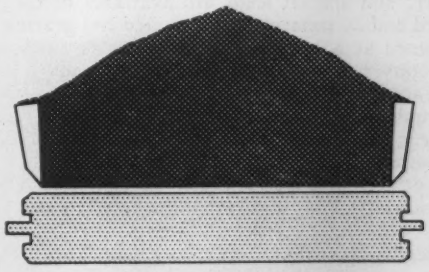
Steeper inclinations are possible with the fluted belting, as much as 10 per cent greater when used plain or 20 per cent greater when crossbars are employed. Actual maximum inclinations for different materials range from 12 deg for potatoes to 20 deg for sand, stone, or ore, and 27 deg for wood chips or clay. Similarly recommended running speeds vary with the type of material and range from 200 fpm for packages to 600 fpm for sand.



Fluted skirts on Numec conveyer belting raise carrying capacity above that of a troughed belt of equal over-all width. The fluting unfolds as the belt passes over the end pulley and not only makes the belt in effect a moving hopper but also increases the degree of inclination that can be used. When crossbars are used, this is even greater.



Cross section through a typical Numec belt



Cross section of a Numec belt fully loaded

Cross section of a troughed belt fully loaded

Exceptional speed and accuracy are features of an extra-heavy-duty 75-hp engine lathe. Surface speed is 288 fpm at 0.0385 feed and 1-in-depth cut. There are 36 spindle speeds in the headstock. The gearbox has 60 threads and feeds.

Heavy-Duty Lathe

THE Sidney 4025, a 75-hp extra-heavy-duty engine lathe, has been developed for steel-mill, foundry, and general-machine-shop work by the Sidney Machine Tool Company, Sidney, Ohio.

New from the floor up, the headstock provides 36 spindle speeds and 75 hp in all speed ranges. It features a 160:1 speed ratio in true geometric progression and the cutting speed is automatically calculated. This enables the machine to remove up to 180 cu in. of metal per min. Greater speed, accuracy, and ease of operation provide reduced operating costs.

Capable of handling stock up to 504 in. in length with a $40^1/_2$-in-diam swing over the bed and a $25^1/_2$-in. swing over the compound, it provides special rigidity with a full-width compound and the three-dimensional truss design of the bed. It can handle torsional loads at the full 75 hp. The bed is full depth the entire length and has replaceable hardened and ground tool-steel ways.

Metric and special leads are available in the totally enclosed and automatically lubricated end gearing which is designed at a 1:1 ratio. This enables quick and accurate conversion for metric and special leads.

Still another important feature of the 4025 is the dual-cam tumbler lock which overcomes possible gear-and-cone-gear unlocking. Here also, 60 threads and feeds are standard on the 4025 for greater versatility.

A depth-reading dial in the tailstock makes it possible to accurately and quickly measure tailstock spindle travel, eliminating operator error. Also, the 4025 provides dual coolant pumps eliminating hoses altogether.

AGS in Operation at Brookhaven

THE Alternating Gradient Synchrotron, AGS, at Brookhaven National Laboratory, one of the world's two largest operating particle accelerators, has been in operation and produced a beam of protons at an energy of more than 30 billion electron volts, Bev. This is the highest energy ever attained by a particle accelerator.

The Proton Synchrotron at the European Organization for Nuclear Research Laboratory, CERN, near Geneva, Switzerland, is quite similar to the AGS. It produced a proton beam of 24 Bev in November, 1959, and has since been run at 28 Bev.

Since 1954, the most powerful accelerator in this country has been the 6.2-Bev Bevatron at the University of California's Lawrence Radiation Laboratory. With a machine in the 30-Bev range, or nearly five times as powerful, physicists at Brookhaven expect to learn more about the many kinds of particles and the various "antiparticles" that are produced in target nuclei by bombarding them with high-energy protons.

Construction of the AGS, which includes 240 magnets placed in a ring-shaped 18-ft sq tunnel $^1/_2$ mile in circumference, was started in late 1955, following several years of preliminary design work. The total cost, including a 60,000-sq-ft service and laboratory building and an 85,000-sq-ft experimental building, is approximately $31 million.

In the AGS, protons are accelerated in three stages. First, a Cockcroft-Walton generator accelerates protons (hydrogen atoms stripped of their electrons and derived from a low-pressure hydrogen gas discharge) to 750,000 volts. The next acceleration takes place in the linear accelerator, or "linac." In the 110-ft-long vacuum tank of the linac the protons are given an incremental velocity as they pass through each gap between 124 accelerating electrodes activated by a high-frequency electrical source. The proton beam, having now reached an energy of 50 Mev, is guided from the linac into the main synchrotron magnet ring through an elaborate injection system of debunching (smoothing out the pulses as they come from the linac), deflecting, focusing, and monitoring equipment. The third stage of acceleration is performed in a $^1/_2$-mile circular, concrete-lined tunnel buried under 12 ft of earth. This tunnel houses the magnet assembly for the AGS. It is the function of the main magnet, which is divided into 240 units, each

weighing some 16 tons, to bend the protons into a circular racecourse, and to apply strong focusing forces. These tend to bring the protons back toward their orbit within the vacuum chamber whenever they tend to stray. Thus the synchrotron's magnetic field must become stronger during the acceleration period. Since the vacuum pipe is only 6 in. wide and $2^3/_4$ in. high, a small fraction of the ring's width, the magnet must be set and aligned to the greatest attainable precision.

The magnet itself does not increase the energy of the beam. This is done by 12 radio-frequency accelerating stations around the ring, each one accelerating the beam by 8000 volts each time it passes. Thus, for each circuit around the ring, the protons gain some 100 kev. In order to reach the final energy of 30 Bev, approximately 300,000 revolutions or 160,000 miles must be traveled in 1 sec. Toward the end of this 1-sec acceleration period, the protons are traveling at a velocity within a fraction of 0.1 per cent of the speed of light, or approximately 186,000 miles per sec. At this velocity, the mass of the protons has been increased more than 30 times, as predicted by Einstein's theory of relativity.

The proton beam is then directed at appropriate target substances, thus producing reactions which can be studied by means of the emitted radiations. It is expected that eventually the primary beam can be made to do double duty by magnetically deflecting it from the vacuum chamber and guiding it into the experimental area, where a number of separate experiments can be installed along the path of the beam and different portions used simultaneously.

Most of the elementary particles produced by the interaction of the high energy protons with the nuclei of the target atoms exist outside the atom for only a fraction of a millionth of a second before they decay into other particles or change their mass completely into energy. These brief lifetimes, however, are long enough for the particles to be detected by instruments—counters, bubble chambers, or photographic emulsions—and to determine their mass, electrical charge, and other properties, or to observe the results when they impinge on secondary targets.

Africa's Kariba Dam

One of the biggest dams in the world has been erected at Kariba in southern Africa. Behind it the waters of the Zambesi River are piling up to form an inland sea 175 miles long and 20 miles wide in places. Covering over 2000 sq miles, Lake Kariba will hold over four times the volume of water impounded by Hoover Dam.

According to the June, 1960, *Machine Age*, the project was first talked about seriously in the early 1950's when a future power shortage began to loom. In 1952, the booming copper-mining area in Northern Rhodesia was consuming 700 million units of electricity a year and the curve was rising rapidly. By 1959 this figure was more than doubled and the Federation of Rhodesia and Nyasaland's total demand had hit the 3-million-unit mark.

A 420-ft-high arch dam was planned for the Zambesi gorge with an underground powerhouse, excavated in solid rock below the right bank, equipped with six 100-mw (140,000-hp) Francis turbines, made by Boving and Company, driving AEI vertical-shaft generators. Plans have been made recently for a second powerhouse to be hewn out under the left bank, which will add between 900 and 1200 mw and bring the ultimate installed capacity of the development to well over 2 million hp.

From Kariba, 330-kv lines—the highest voltage in the southern hemisphere—run northward to the copper belt and south to the industrial centers of Southern Rhodesia. The whole grand plan will provide over 8 million units of electricity a year—enough for at least a decade of expansion—at a cost of £80 million for the first stage, with a further £34 million for the second.

The World Bank, the British and Federal Governments, banks, and copper companies together provided the credit.

Roads capable of carrying 100-ton loads had to be built and a town constructed to house 10,000 workers and families—mostly Africans new at this work.

As finished, the dam is almost semicircular in plan with a 40-ft roadway carried around the 1900-ft crest. Six flood gates can discharge 336,000 cu fps if necessary.

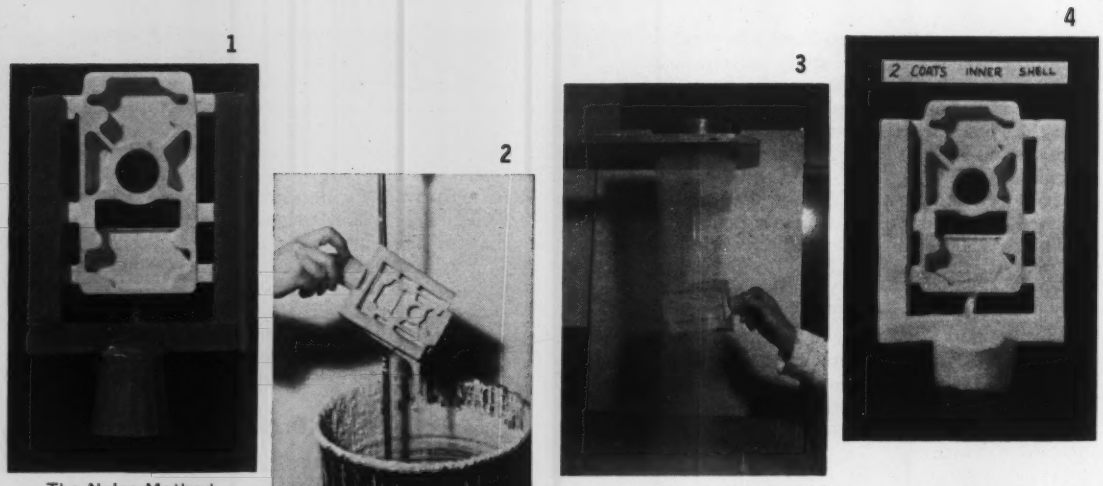
Inspecting Hole-Center Locations

The Ferranti FI-22 Co-ordinate Inspection Machine, a compact, solid-state unit which can read out hole-center locations in two axes simultaneously to an accuracy of 0.001 in., is being introduced by the U. S. distributor, the Bendix Corporation's Industrial Controls Section, Detroit, Mich. This unique single-unit inspection laboratory is capable of checking complex workpieces up to ten times faster than conventional inspection equipment.

Measurement is accomplished by moving a probe along a fixed axis to which is attached an accurately ruled grating. A moiré fringe pattern is created by the imposition of a movable reference grating over the fixed grating. By reading both the dark and light phases of the fringe pattern, the electronic counting units of the FI-22 are able to record 0.001-in. increments on a scale which is ruled with 500 lines per in. Probe position is displayed on two sets of position indicators—one for each axis. The system will accurately record probe movement at speeds of up to 30 ips.

The FI-22 is an extremely flexible machine. It has a floating zero which may be established at any point with its 24 × 15-in. working range. Positive motion may be read in either direction through the use of inverting switches for each axis. A selection of interchangeable taper probes and flat-center ground probes will permit the inspection of any hole or edge location. By using a scribe in place of the inspection probe, the machine is capable of fine layout work.

Hole-center locations can be read in two axes simultaneously to an accuracy of 0.001 in.



The Nalco Method

1 The wax pattern mounted with wax runners and sprue cup 2 is dipped in ceramic slurry and the excess allowed to drain. 3 Stuccoing is applied to the slurry-coated pattern until the entire surface is covered and then dried. Two coats have been applied 4, and more can be used to build up shell thickness. The inner shell surface duplicates surface of wax pattern.

Ceramic-Shell Investment Casting

Two companies report significant improvements in the investment-casting process through the use of ceramic-shell molds.

The Arwood Corporation, New York, N. Y., has announced a new casting process which can produce intricately shaped investment castings weighing up to 100 lb. Castings are being turned out in actual production runs in virtually all castable alloys.

Previous investment castings made in a solid mold were limited to a size easily held in the palm of the hand. But the new Arwood Ceramic-Shell process, besides greatly increasing casting size, offers many additional advantages: (*a*) It is possible to produce parts with far more intricate coring; (*b*) the ceramic-shell process can produce shapes which cannot be made by any other method; (*c*) castings produced by this new method have a finer grain structure; (*d*) better and more consistent surface finish is realized; (*e*) there is greater freedom in engineering the casting setup, resulting in generally sounder castings; (*f*) much less finishing is required than with ordinary solid-mold castings.

Designers have long turned to investment casting when they needed intricate shapes or when parts were in hard-to-machine alloys. The process was ideal, too, where quantities were limited or the design was not finalized and subject to frequent change.

Besides these advantages, investment casting could frequently eliminate numerous machining operations.

In its broad definition, the term "investment casting" is defined as a metal-casting process employing an expendable pattern in conjunction with a one-piece mold made of ceramic materials.

Until recently, there were two basic systems in use: (*a*) Solid mold, using wax or plastic patterns which are inserted in a flask and invested with the ceramic material; (*b*) shell mold, using frozen-mercury patterns.

Arwood's new development adds a third system—shell mold, using wax or plastic patterns.

Arwood is equipped to use all three systems for producing investment castings, and feels that there is no one best system or method for doing all casting jobs.

The first dividing line in the choice of process is size. If a number of parts can be clustered in a standard flask of 6 × 6 × 9 in., then it probably would be most satisfactory to produce the part by the conventional or solid-mold system.

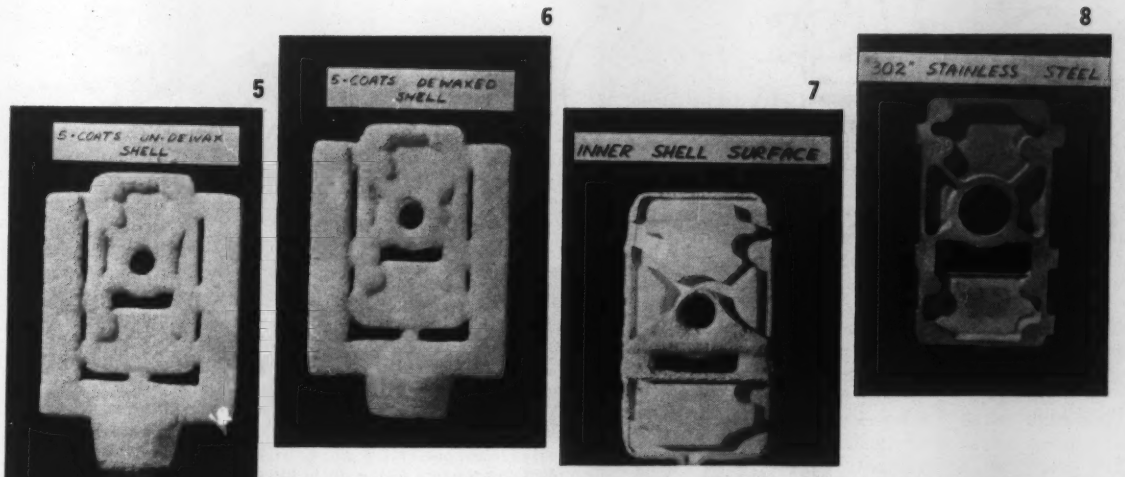
If, on the other hand, one casting and its gating arrangement would not fit that size flask, or if certain metallurgical considerations are involved, then probably it would be most feasible to turn to the shell process. If it is an extremely large part the frozen-mercury process might prove the best one to use.

The biggest problem in determining what process is best comes in "fringe-area" castings—parts which could be made by more than one process.

To determine which to use, three basic factors must be considered: (*a*) Metallurgy—there is greater freedom in designing the gating arrangement for shell than there is for solid mold. Cooling rates are different, too, with casting geometries dictating in general, which system is best. (*b*) Ceramics—the shell systems provide greater freedom in orientation, particularly when blind holes or peculiar coring are encountered. (*c*) Economics—if the part could be made in a choice of ways from a technical standpoint, then economics would be the deciding factor.

Nalco Chemical Company, Chicago, Ill., reports the recent development of an improved ceramic-shell mold made from Nalcast, a processed form of high-purity fused silica; and Nalcoag, an aqueous colloidal silica sol. This increases the utility of the investment-casting process according to an unpublished paper by Paul Schlinkmann and Raymond Reuter, "New Ceramic Shell Revolutionizes Investment-Casting Process." A minimum of specialized foundry equipment is required to economically make castings of small and relatively large size of most ferrous and nonferrous metals. The only other material used in the mold preparation is the wax pattern which represents the shape to be cast.

The pattern of the finished casting is made by injecting wax into carefully prepared dies. When the wax pattern is removed it can be placed on a wax central sprue if the patterns are small so that one single casting of several pieces can be made. With larger patterns, single castings are made.



5 Additional coats provide strength and permeability. After a thorough drying in air at room temperature, the shell is ready for dewaxing **6**, done in a 1400 to 2000-F oven. The wax melts and burns at that temperature without the cracking of the shell that would take place at lower temperatures. **7** The inner surface of the ceramic shell reproduces such fine detail that visible fingerprints on the wax pattern are reproduced. **8** Type 302 stainless-steel casting.

To prepare the ceramic-shell mold the single pattern, or cluster of patterns, is dipped into a precoat slurry which is the surface in contact with the finished casting. The precoat slurry is allowed to drain and ceramic is sifted onto the wet precoat, creating a stucco effect and building up thickness and strength of the shell. After being allowed to dry, the procedure is repeated. The pattern is now precoated with a very fine ceramic surface and is ready for the addition of the remaining coats which complete the ceramic-shell mold.

The precoated pattern is dipped into a backup slurry which is made from a coarser ceramic and silica sol. After draining, the backup slurry is stuccoed with a coarser ceramic. The number of coats to be applied to any one cluster or pattern is governed by the total weight of metal to be poured. As a general rule, five coats are applied for 10 to 20-lb castings, six coats for 20 to 30 lb, and so forth. An average of one coat every $^1/_2$ hr can be applied under suitable conditions. The ceramic-shell mold is then dried thoroughly and the pattern material removed by firing directly at 1400 to 2000 F, varying with patterns, for from 10 to 20 min. The pattern will be completely removed during the firing and metal can be poured at any convenient time thereafter.

Rapid firing of the shell melts wax from the surface of the pattern before the pattern as a whole is heated sufficiently to expand. This fact, together with the low coefficient of thermal expansion of the ceramic (5.4×10^{-7} per deg C from 0 to 1000 C), is the basis for successful development of the ceramic-shell mold.

Lower metal-pouring temperature may be used with ceramic-shell molds. The mold may be preheated before pouring. Quick heating to as high as 2000 F to within seconds of the metal pouring permits fill-out of thin sections. The rapid rate of heat transfer through the relatively thin walls of the shell allows rapid cooling of the casting. This results in cleaner metal surfaces and better casting metallurgy. In contrast, solid molds retain heat for longer periods causing larger grain size.

In addition, the ceramic can be used for permanent backup for foundry molds; to improve sand facings in split molds by spraying slurries on the surfaces and into cavities; as ceramic composition to be incorporated in high-quality cope and drag molds, giving better dimensional control as well as surface finish; to make preformed ceramic shapes; as one-piece furnace hearths to be used continuously or intermittently at temperatures up to 2400 F to strengthen resin shells and cores; or to make ceramic facing plates for die casting.

Gas-Turbine Jeep

A LIGHTWEIGHT gas turbine that is an adaptation of the first gas-turbine outboard motor announced last winter by Williams Research Corporation, Walled Lake, Mich., will be installed and tested in a jeep. The Detroit Ordnance District, under the technical supervision of Ordnance Tank Automotive Command in Detroit, has awarded the contract.

According to the president of the company, Sam Williams, Mem. ASME, the engine which weighs only 50 lb and develops 75 hp, is the smallest gas turbine ever to be tested in any vehicle, and will replace equipment weighing several hundred pounds more.

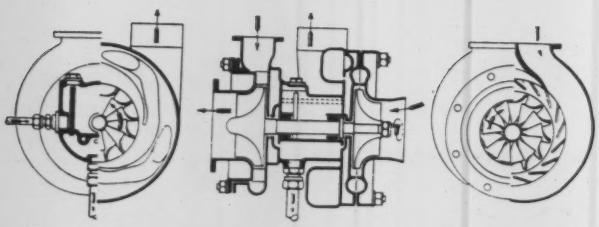
Inherent durability, longer operating periods without service, suitability of a wide variety of fuels, and ability to deliver high torque at low vehicle speeds without complex transmissions were cited as other advantages of the new power plant.

A limited sports-car market is regarded as a possible key to introduction of gas turbines for general automotive use.

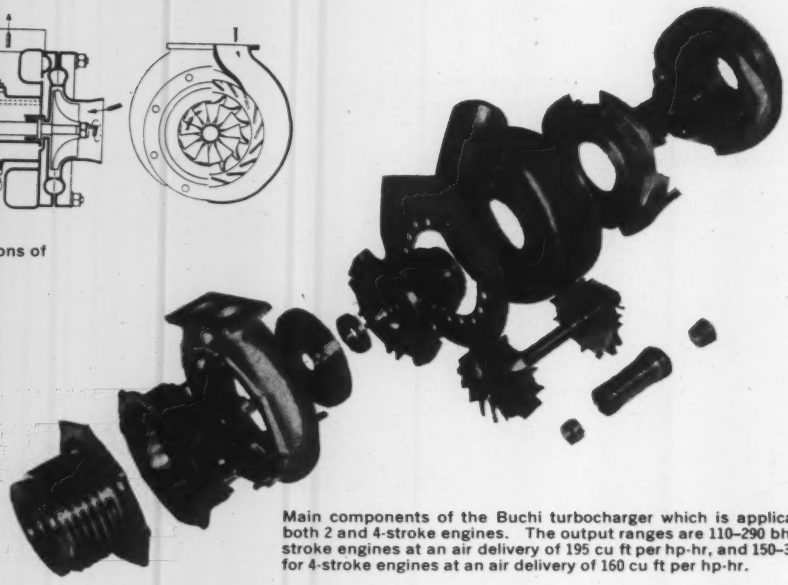
The basic engine is smaller—only 10 in. in diam and 19 in. long, less accessories and gear case—and lighter than the marine engine announced last winter, but does not incorporate a regenerator and has a high fuel rate.

"While this smaller unit will be preferred in certain vehicle applications," Mr. Williams stated, "any general automotive usage beyond the limited sports-car field would require the regenerative version."

He added that the regenerative marine engine development is progressing with excellent results and that vehicle installations would be considered in the near future.



Longitudinal and cross sections of the Buchi B-115 turbocharger



Main components of the Buchi turbocharger which is applicable to both 2 and 4-stroke engines. The output ranges are 110–290 bhp for 2-stroke engines at an air delivery of 195 cu ft per hp-hr, and 150–360 bhp for 4-stroke engines at an air delivery of 160 cu ft per hp-hr.

Buchi Turbochargers

THE first of a new series of turbochargers developed by the engineering office of the late Alfred J. Buchi is ready for production. (See MECHANICAL ENGINEERING, February, 1960, p. 144, for his obituary.)

Known as the B-115, according to the July, 1960, issue of the British *Oil Engine and Gas Turbine*, this first model is applicable to both two and four-stroke engines. The output ranges are from 110 to 290 bhp for two-stroke engines at an air delivery of 195 cu ft per hp-hr, and 150 to 360 bhp for four-stroke engines at an air delivery of 160 cu ft per hp-hr.

For optimum results the Buchi turbocharging system is allied to a valve timing in which the exhaust valves close later, and the inlet valves open earlier, so that the overlap is greater than on the nonturbocharged engine. The resultant intense scavenging by the charging air contributes considerably to the cooling of cylinder head, cylinder wall, piston and valves, and thus prolongs engine life. Valve overlap may be of the order of 140 deg. Approximately one third of the delivery air is used for scavenging and cooling, the remaining two thirds serving in the pressure-charging capacity.

Four-stroke turbocharged engines are normally provided with relatively small, separate exhaust pipes, valves of large cross section and lift rate. On multicylinder engines, optimum power is obtained by the separation of the exhaust pipes in accordance with the number of cylinders and the firing order. This is to prevent the scavenging process of one cylinder being affected by the exhaust-pressure shock waves of a firing cylinder.

Turbocharging of two-stroke engines is relatively new although output has already been boosted in comparison with normally aspirated engines by as much as 300 per cent on higher-powered types. The amount of increase has depended on the scavenging process.

The Buchi rotor is elastically supported within the bearing casing by being mounted in two plain floating bearings located between the two overhung runners.

The bearings are enclosed in bearing bushes, which can easily be removed as compact units together with the rotor. The design has the advantages of a simple, compact construction permitting a free supply of air and an unhampered flow of gases in the axial direction.

The plain bearing is protected from radiated heat on the turbine side by a bore in the rotor shaft assisted by built-in heat-radiation shields.

Sealing air is fed from the blower collector casing to the turbine-side bearing, helping to prevent oil losses, giving additional cooling, and compensating for axial thrust.

The turbocharger lubrication system is connected to the engine via a microfilter. In the larger sizes, a separate lubrication system may be fitted where required. A constant-level oil reservoir, built into the bearing casing, maintains the oil supply to the plain bearings during idling of the charger.

The turbine wheel is made from heat-resisting precision cast steel, and the blower wheel from precision cast light alloy. Minimum weight and low moment of inertia are achieved by the use of very thin blades and by recessing the rear disks. Consequently the rotor has notable acceleration characteristics. The turbine wheel is welded to the rotor shaft by a special process, and the blower wheel is shrunk on the rotor shaft. Drive is effected by polygonal profiling without any notch effect. Within the delivery range of the turbocharger, two series of four standard blower wheels are available, one series covering the higher pressure ratios of over 2 to 1. As larger models in the series become available, it is the intention that the largest blower wheel of one model will give the same delivery as the smallest wheel of the next larger size, so that the most suitable machine may be chosen for any given application.

Details of Buchi B-115 Turbochargers

Charging pressure ratio	max. 3 to 1
Air delivery at ratio 2 to 1, cfm	290 to 930
Maximum rpm	70,000
Gas temperature before turbine (continuous operation), F	1290
Weight, lb	40
Over-all height, in.	9 1/2
Over-all width, in.	9 3/16
Over-all length, in.	10 1/4

Moving Sidewalks

Moving sidewalks will soon provide ample and rapid pedestrian transportation in the central business area of Tacoma, Wash.

Four pairs of Speedramp passenger conveyers produced by Stephens-Adamson Manufacturing Company of Aurora, Ill., and featuring special Goodyear grooved belting will carry pedestrians up and down four separate business blocks.

The conveyers will be installed in adequately lighted tunnels through existing buildings or in a covered and protected areaway where existing obsolete buildings are being demolished.

The average incline of the ramps will be approximately 11 deg and all will be equipped with moving handrails and grooved nonskid rubber belts for the moving surface.

Among the safety features of the Speedramp conveyers are a floating comb plate at threshold points working in conjunction with the finely grooved Goodyear belts, and a foolproof double system of microswitch cutoffs, designed to stop belts and handrails instantly in emergencies.

Installation of moving sidewalks as an integral part of the revitalization of downtown Tacoma was recommended by a 250-member Citizens' Committee for Tacoma's Future Development. The voters approved an $875,000 bond issue in March, 1958.

Installation of the first set of moving ramps should be completed this fall and the total project is expected to be finished by late this year or early 1961.

Variable-Ratio Transmission

A mechanical variable-ratio transmission that incorporates features not available in conventional gearboxes has been announced by Avco Corporation's Lycoming Division, Stratford, Conn. Outstanding features are an infinitely variable speed ratio, operation in extremely high or low ambient temperatures, and simple, compact design.

The transmission is the variable-ratio drive section of a 65-hp constant-speed drive developed by Lycoming for the U. S. Navy. The company also revealed that a 125-hp model is being developed under subcontract to North American Aviation, Inc., in connection with the Air Force Hot Elect program (a high-temperature investigation for a 600-F electrical system). This advanced model is in the prototype-construction phase.

The transmission's infinitely variable ratio will be of great value in machine tools, such as mills or lathes, because they need no longer be limited to the relatively few fixed operating speeds of a conventional transmission. Other possible uses include driving pumps in chemical processing plants, in automobiles, or in almost any application now handled by conventional gearboxes.

Efficiency of the Lycoming transmission is more than 90 per cent over the full speed range. This approaches good gearbox efficiency and means that less horsepower is required to drive the unit for a given output.

Currently, the drive is being used in ambient temperatures from −65 to +600 F, with oil-inlet temperatures up to 600 F. Most applications involve oil temperatures in the range of 200 to 300 F.

Basic components of the transmission are two toroids and three rollers. The toroids are disks, on the same rotational axis, with partial toroidal surface cavities.

The toroids face each other and form a full toroidal cavity in which the rollers are mounted on a fixed cage or center section. The rollers, small disks, have the same diameter as the cavity; therefore the rollers can be tilted in the cavity to vary their contact diameters on each of the toroids. The tilting of the rollers against the toroidal surface results in an infinitely variable speed ratio.

Mechanical preloading of the roller-toroid components, through the toroidal axis, permits the transmission of power by traction from the input to the output toroid. The output speed can be selected manually or can be controlled automatically.

Reliability of the design is achieved with conventional machining tolerances. It is insured by the low number of parts and strict quality-control procedures already in use in the production of missile components and gas-turbine and reciprocating engines. More than 8000 hr of development, qualification, and flight testing have demonstrated the high reliability in the operation of the transmission.

Peristaltic Pumps

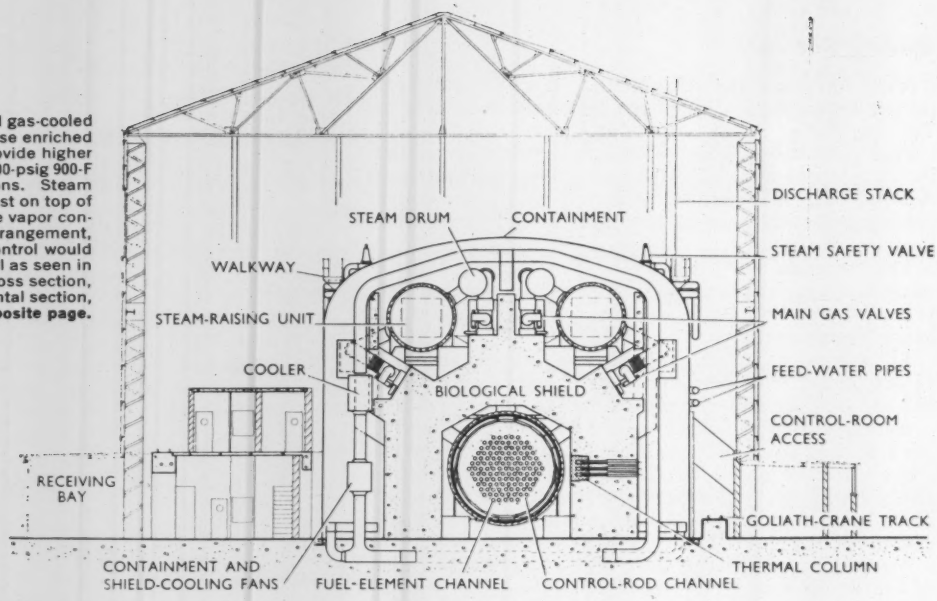
Pumps designed to move liquids, slurries, or gases without the pumped fluid coming in direct contact with the pump parts are made by Sigmamotor, Inc. The possibility of contamination is completely avoided, and pumped fluids may be kept absolutely sterile if necessary. The fluid moves through flexible tubing by linear peristaltic action. This is provided by 12 chrome-plated fingers operated by 12 cams, each 30-deg eccentric to adjoining cams. These metal fingers press resilient flexible tubing in wavelike sequence against a spring-mounted stainless-steel pressure plate. This action imparts a positive unidirectional movement to fluid in the tube. The cycle of the operating fingers is timed so that the tubing is always tightly closed at some position, thereby eliminating the need for any external check valves.

The tubing through which fluids are pumped may be gum rubber, neoprene, or Tygon of a good grade in proper sizes. Life expectancy of tubes in the pumps depends on the kind of tubing, the speed of operation, and the rate of chemical reaction with the substance being pumped. Gum rubber and neoprene tubes will usually last about 50 hr at 500 rpm with no chemical reaction present. Tygon tubes provide 600 to 800 hr of service under the same conditions. Chemical reaction can decrease tube life considerably. Slower operation of the pump increases tube life.

The standard Zero-Max variable-speed drive is equipped with a knob-on-shaft speed control, which is adequate for many uses. For more precise control of flow rates, the Zero-Max unit may be equipped with a vernier-knob speed control. Explosion-proof motors are also available.

Absence of valves in the Sigmamotor pumps allows smooth operation with no clogging. Many highly corrosive acids can be pumped easily without damage to the pumping units. Movement of slurries poses no problems. Most Sigmamotor pumps are multiple feeders, that is, they can accommodate several tubes at once, permitting the separate transmission of different fluids to be obtained simultaneously through one pump.

A 30-emw advanced gas-cooled reactor would use enriched uranium to provide higher burnup and 900-psig 900-F steam conditions. Steam generators nest on top of reactor inside vapor container. Core arrangement, charging, and control would all be horizontal as seen in transverse cross section, **right,** and horizontal section, **opposite page.**



G.E.C. Gas-Cooled Reactor

A PRELIMINARY design for a 30-emw advanced gas-cooled reactor with a number of novel features is proposed by M. Lindfield in the Spring, 1960, issue of the *G. E. C. Atomic Energy Review* published by the General Electric Company Limited of England.

The core output would be greater than that of current reactors because of the use of UO_2 with 2.16 per cent U-235 enrichment. The higher burnup would make possible 900-psig 900-F steam conditions and the use of conventional turbogenerating equipment.

Canned fuel elements in graphite sleeves would be loaded into 121 horizontal channels passing through the core. This horizontal arrangement has several advantages, including access to both ends of each channel, complete separation of control and charging faces, good natural circulation of gas within the primary circuit, and compact layout within the containment shell.

Reactivity control would be provided by stainless-steel rods driven by electric motors through chain-type mechanisms, normally at 4 ipm although emergency insertion could be completed in 10 sec. In addition, there would be 23 pneumatically actuated boron-steel shutdown rods in a completely independent system for very rapid insertion.

The graphite moderator and reflector materials would be keyed together in hexagonal-section blocks in such a way that both Wigner and earthquake effects would be accommodated. The graphite would be supported in a steel reactor pressure vessel insulated to reduce temperature gradients.

The reactor vessel proposed is a horizontal cylinder with semiellipsoidal ends. The core assembly is surrounded by a $^1/_8$-in-thick boron-steel shield, which reduces the production of neutron-capture gamma radiation from the steel of the pressure vessel and also reduced activation of the gas ducts. As a result, the thickness of the main concrete biological shield and nuclear heating within it are reduced. The main concrete shield consists fundamentally of two 9-ft 6-in-thick side walls bridged by an 8-ft top cap and joined at the ends by considerably thicker walls containing the standpipes.

Secondary shielding of the steam generators and gas ducts is provided by 1-ft 6-in-thick concrete walls or equivalent steel plates where removal for maintenance is necessary.

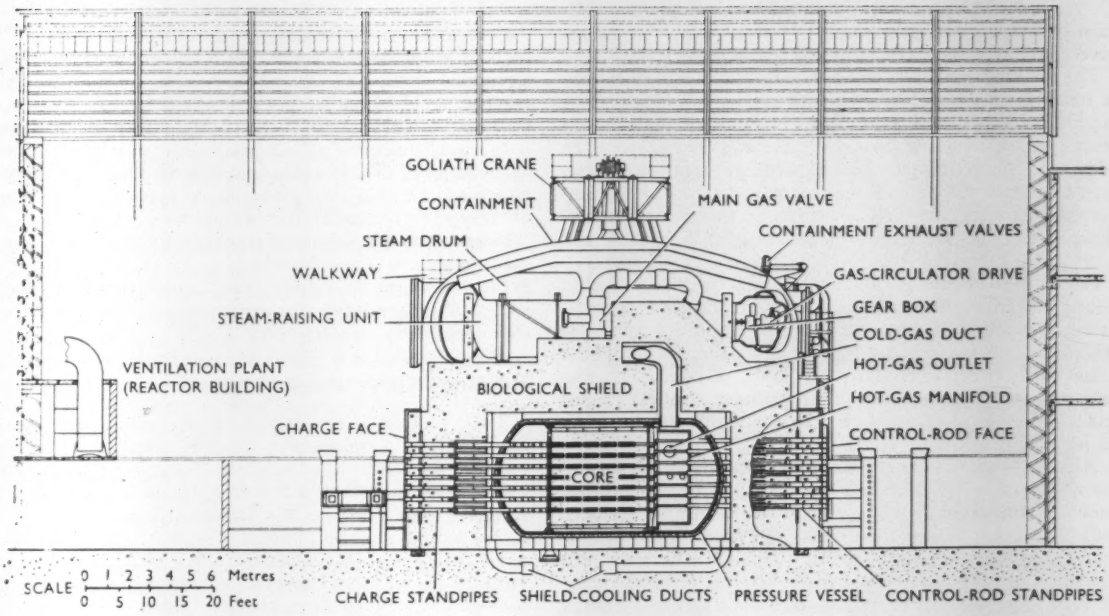
Cooling of the shield as well as the core is achieved by circulating CO_2 through suitably positioned ducts and then through a water-cooled heat exchanger. This arrangement maintains the whole of the equipment within the containment at a satisfactory temperature. The use of CO_2 instead of air removes the problem of argon activation otherwise present.

Steam generators rest on the concrete biological shield and are inside the containment vessel which consists of a vertical steel cylinder having a semiellipsoidal head. The lower end is flanged and bolted down to the concrete foundation. The flange is sealed by a gasket and is then "built in" by the use of expanding concrete.

The fuel-charging machine consists of two similar magazines arranged in tandem inside a pressure vessel, one end of which terminates in a bellows sealing nozzle. Since the machine operates from outside the containment with the reactor on load, it is itself contained in an outer pressure vessel which also has a bellows sealing nozzle. The closed end of the containment vessel houses the charge chain, together with its driving mechanism, drives for the magazines, and position-indicating mechanisms. The whole machine is suitably shielded and is fitted with flexible connections for power, instrument, and gas supplies.

In loading, the charge machine is moved to its position in front of the loading magazine and the machine nozzle is sealed to the loading face. The machine-containment and pressure vessels are purged of air and filled with CO_2, the former at containment pressure, and the latter at reactor pressure. This CO_2 is taken from the main coolant circuit.

The charge chain which has a CO_2-operated grab head at its outer end is driven out until it enters the loading magazine, and the grab head latches onto the reflector sleeve which is then withdrawn into one of the charge-



machine magazines. The machine and loading magazines are then indexed, and the procedure repeated for each of four fuel elements and for the various sealing plugs and sleeves to replace the existing ones which will be withdrawn for maintenance. The machine nozzles are then sealed, and the machine is moved onto its support at the charge face.

The analysis of generating costs is based on U. S. prices for enriched fuel, on an annual rental charge for fuel of 4 per cent, and an amortization rate of 14 per cent including insurance against nuclear risks. The assumed annual operating time is 6000 hr, and the average burn-up 10,000 megawatt days per ton of uranium.

A total generating cost of 1.39 pence per kwhr (about 1.628 U. S. cents) would be made up of 1.02d based on annual charges on capital cost, 0.03d on annual fuel rental charge, 0.01d on annual charges for fabrication of first fuel charge, 0.22d operating costs for a staff of 50 men and maintenance, and 0.11d for fuel-replacement.

Fuel-Element Development

"The fuel elements present the most difficult materials problems in any reactor," according to R. Carson Dalzell, chairman of the ASME Nuclear Engineering Division, and assistant to the director, Division of Reactor Development, U. S. Atomic Energy Commission. Dr. Dalzell's address on "Nuclear Fuel Element Development" was the 1960 Gillett Memorial Lecture, at the annual meeting of the American Society for Testing Materials, Atlantic City, N. J., June 28, 1960.

In only one type of reactor is there no fuel-element problem. This is the so-called homogeneous reactor, in which the coolant and fuel are circulated together and in which the moderator also is usually a part of this circulating fluid. In these reactors the materials problems are equally severe but they pertain to containment rather than the fuel elements.

At the end of World War II there was one usable fuel-element design for one type of reactor—a plutonium producer. To fully appreciate that this in itself was a great accomplishment, one must realize that, with about 100,000 fuel elements in this reactor, the failure of just one would shut the reactor down for a day or more.

Today, excluding critical facilities, there are approximately 140 reactors of all types operating in the United States with many more being designed and built.

Fuels Available. Only three fuels are available for nuclear-reactor use: U-235, plutonium derived from U-238, and U-233 derived from thorium. A common remark among metallurgists is that uranium has only one good property —it is fissionable. Plutonium also has some unattractive metallurgical properties, but it will probably always be used in a diluted form. Its only real handicap is that even when alloyed it must be handled remotely for protection. U-233 is like plutonium in this respect.

Importance of Coolant. Any nuclear reactor can be simply described as a primary source of heat. It may serve another purpose, such as producing plutonium, but the fact remains that, so long as the fissioning process is continuing, heat is being generated. The only limitation on operating power level is the rate at which this heat can be removed from the reactor.

A useful analogy is to consider the nuclear fuel element to be an electrical resistance-heating unit connected to an infinite, but controlled, source of electricity. There is a steep temperature gradient from the core to the surface of the element. The element will melt if one allows the heat-generation rate to exceed the rate at which the coolant can remove heat from the surface. Surface corrosion must be minimized not only to preserve the element but also to prevent corrosion scale from interfering with heat transfer. With the high heat-transfer rates required, even a small scaly spot becomes a critical hot spot. Heat-transfer rates are as high as 1,000,000 Btu per sq ft per hr. Temperature gradients on the order of 10,000 to 20,000 deg F per in. are fairly common. It is necessary to use factors like this to hold down the size and hence the capital costs of the plants. Uranium is a very low cost fuel—negligible in the ideal case—but the plant to

burn it is still very expensive and so is the process for recovering and reusing the unburned part of the fuel.

The fissioning process itself depends on a steady supply of neutrons. But these neutrons damage nonfissioning materials in several ways including displacement of atoms, transmutation of elements, and radiolysis. In addition, the fission event itself also involves transmutation of elements, equivalent to the introduction of impurities into the fuel-element crystal structure. Some of these impurities are solids, some are reactive gases, and some are noble gases which create internal pressures.

Coolant Experiments. Briefly reviewing the more than a dozen coolants in use or in development, Dr. Dalzell indicated a few of the unusual experiments being made. He stated that: "Dust carried by a gas is proving to be a remarkably effective coolant. It will, of course, be erosive and it will cause the entire primary-coolant circuit to become radioactively hot. Practicability cannot yet be judged."

All the civilian power reactors operating in this country are liquid cooled and by far the most experience has been accumulated with water. To minimize induced radioactivity, this is demineralized and degasified as completely as possible. For thermal efficiency the temperature is pushed toward the critical temperature—in fact, serious consideration has been given to using supercritical water. Although these conditions have been handled satisfactorily in fossil-fuel plants with fairly conventional materials, radiation effects and neutron-absorption properties are added to corrosion problems when considering them for nuclear plants.

Almost 10 years of strong investigative programs have been required to understand and solve both the basic and applied problems associated with organic coolants—hydrogen release from radiation damage, breakdown of molecules, and polymerization.

The real problem has been to remove potential sludge-formers to prevent impairment of the heat-transfer surfaces. Cost of replacement and cost of treatment of the organic are governing factors. Terphenyls have so far proved the most practical material to use. However, one reactor manufacturer is seriously considering the use of fuel oil on a fast-replacement basis, burning the used oil in a superheater.

Design Requirements. Turning to the design requirements that are not strictly related to the environment in which the fuel element must live, foremost is the concept that a fuel element is a concentrated heat generator. It must have adequate surface, an acceptable internal temperature gradient, and structural strength. Selection and design for a specific reactor are based on many additional interrelated factors. There are many possible shapes. Fluid dynamics, degree of U-235 enrichment desired, alloy or dispersion or ceramic fuel core, and manufacturing capability are a few controlling factors.

Many knowledgeable people expect the cladding requirement for fuel elements to be abandoned in five to 10 years. It is standard practice now for all heterogeneous reactors being regarded as a first containment barrier between highly radioactive material and the public. The plant operator also feels that he would rather pay the price for cladding than to face the problems and costs of maintenance with a highly radioactive primary coolant.

The major cost for fuel can be reduced by obtaining longer fuel-element life since chemical-processing and first costs, although large dollar amounts, practically vanish as a factor in "mills per kwhr."

One method of extending the interval between refueling of enriched reactors has been the incorporation of a planned amount of "burnable poison" in the core of the reactor. This became possible once it was recognized that neutron absorbers, formerly used only in the control rods, each "burned" at a characteristic rate by absorption of neutrons. Their incorporation in the core permits charging enriched U-235 far in excess of what would otherwise be tolerated from a reactivity standpoint.

Current Problems. Currently the research and development problems of fuel elements can be stated quickly by a gross oversimplification. The objectives are longer life, higher operating temperature capability, and lower cost—probably in that order.

Heating With "Cold" Light

THE new foot-candle levels recommended by the Illuminating Engineering Society generate sufficient heat—even with "cool efficient fluorescent"—to heat a building with a design temperature of +10 F with the lighting system as the sole source of heat.

According to the August 1, 1960, issue of *Electric Light and Power*, the 22-story office building being constructed for Georgia Power Company will utilize the new foot-candle levels throughout. Heat gains and heat losses in the $7.4-million building are "normal" or average. Approximately 37.5 per cent of the cost of the building is in electrical equipment.

The lighting system, even using fluorescent exclusively, will produce slightly more Btu's than the +10-F design required for the Atlanta area. Both heating and cooling will be required at the same time on the same floor on cold days.

A dual-duct or "hot and cold" deck system will use mixing boxes that are fed by hot-air ducts and cold-air ducts which are controlled by zone thermostats. The mixing box is the air-delivery source for the particular area or zone being heated or cooled and delivers whatever temperature air is called for by its particular thermostat in the 53 to 90-F range.

The heat from the recessed troffers which constitute the lighting system is collected from the plenum and introduced into the hot-air-duct system. Thus it is carried from the interior offices that are being cooled over to the exterior offices that are being heated. The real bonus is that, come summer, a means of collecting and exhausting the heat to the outside is provided, greatly reducing the amount of air conditioning needed.

Night heating presented a problem that brought about departure from an all light-heat system. If light were used as the heat source at night, it would require frequent starting of the lights. Since whole floors would blink on and off on cold nights under the control of the set-back thermostats, the public relations value was considered doubtful.

Instead, 87 kw per floor of 500-watt resistance-heating units were installed under the windows of the outside offices and in the hot-air ducts. These operate only at night or on very cold days.

The 90-kw-per-floor lighting system provides 27 Btu per sq ft for heating and 36 for air conditioning.

The average level of 100 ft-c requires extra air conditioning—528 of the 1050 tons are for the lighting alone, the balance being for the people, machines, windows, and so forth. Total electrical and air-conditioning costs are $7.50 per sq ft.

Power Loss of Tires

TIRE construction and type of rubber are the main factors determining the manner in which power loss of tires varies with changes in speed, load, and inflation pressure, it is concluded from a new study.

Power loss may be defined as the power dissipated in the form of heat within a tire when it is rolling under load. It is a measure of the hysteresis or internal friction of the tire.

A National Bureau of Standards study of the power loss of tires under controlled laboratory conditions has been completed for the Federal Facilities Corporation.[1]

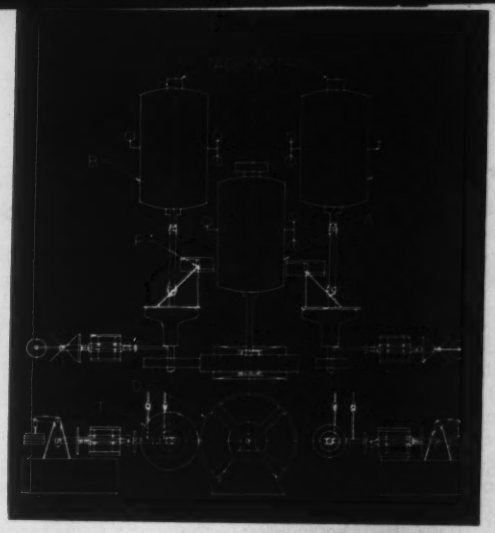
The high operating temperatures that result from the power loss of tires often cause premature failure. Although the problem has long been recognized, few systematic studies have been made. Sustained high speeds, contemplated changes in tire design, and possible use of new polymers and cords in tire construction have emphasized the need for quantitative data on tire performance obtained under controlled laboratory conditions. To provide such data, R. D. Stiehler, Mem. ASME, and co-workers of the NBS staff undertook the present study.

In the equipment used for the experiments, power loss in large-sized tires was measured with two dynamometers, one for power output and the other for power input. The first dynamometer, which provided the necessary tractive effort, was connected to a steel drum; the second, to a truck-tire assembly located next to the steel drum. The plane of the tire was aligned with the plane of the drum. Load was applied to the tire by weights acting through a lever arm which thus forced the tire against the drum.

To evaluate passenger-car tires, a standard-sized tire assembly connected to a third dynamometer was mounted on the other side of the steel drum and operated in a similar manner. Both of the dynamometers connected to the tire assemblies were instrumented to permit measurement of speed to within 0.1 rpm, and of torque to within 1.0 per cent of the difference between input and output torques.

The equipment was enclosed in a housing so that the temperature of the atmosphere could be controlled. A previously developed method, in which a copper-constantan thermocouple is inserted through the tire valve,[2] was used to measure the temperature of the air contained in the tire under study. To measure inflation pressure, the valve stem of the specimen was connected through a rotating joint to a precision pressure gage.

In the experiments, the specimen was first preconditioned by rotation against the drum for 16 hr at 45 mph, under from 80 to 100 per cent of maximum load. After preconditioning, the load, speed, and inflation pressure were adjusted to the desired values, the axle of the rotating tire was made parallel to the axle of the steel drum, and the tire was run until the temperature of the contained air remained constant. Readings were then taken of the torque on the dynamometers, their speed, and the inflation pressure; and the temperatures of the ambient air and of the contained air were recorded. For convenience in comparing the specimens, the dimensionless



Equipment used to measure power loss of tires: **A**, absorption dynamometer connected to steel drum **D**. **B**, dynamometer for driving the truck tires **T**. **C**, dynamometer for driving car tires. **P**, ball-and-socket pivot used for aligning plane of tire with plane of drum.

An NBS study shows how the temperature rise of air within the tire per unit power loss ($\Delta T/P$), in deg F per hp, is affected by changes in the product of speed and load (**SL**) in lb-miles per hr

rolling-resistance coefficient R was derived from

$$R = P/SL$$

in which P is power loss in ft-lb per min, S is speed in fpm, and L is load in lb.

Experiments were conducted at speeds of 5 to 50 mph under constant loads from 1000 to 5000 lb, at inflation pressures from 60 to 120 psi. Rolling-resistance data were compiled for tires varying from 7.00-15 passenger-car size to 11.00-20 truck size, constructed either of natural or synthetic rubber, or a combination of both; containing 1 of 7 different kinds of carbon black; and having rayon, nylon, or steel-wire cords.

An analysis of the data showed that the rolling-resistance coefficient of passenger-car tires was greater than that of truck tires. The effect of inflation pressure on R was practically independent of speed at normal loads, but markedly dependent on speed at low loads. In the truck tires studied having either nylon cord or steel-wire cord, a decrease in R occurred with increasing speed; tires with rayon cord showed either no change or a linear increase in R with increasing speed. In passenger-car tires, R increased at a growing rate with increasing speed, particularly in a rayon-cord tire. R increased with load in all but steel-wire-cord truck tires.

The type of carbon black used had little or no effect on R; however, the type of rubber had a pronounced effect, natural rubber having lower power loss than styrene-butadiene synthetic rubber, SBR. When natural rubber was substituted for SBR in either the tread or the carcass of a tire, the resulting decrease in power loss was not as large as would be anticipated from a comparison of 100 per cent natural-rubber tires with 100 per cent SBR tires. The operating temperature of a tire was found to depend on power loss and on thermal conductivity of the rubber, as well as speed, load, and ambient temperature.

[1] For further technical details, see R. D. Stiehler, N. M. Steel, C. G. Richey, J. Mandel, and R. H. Hobbs, "Power Loss and Operating Temperatures of Tires," *J. Research NBS*, 64C, 1 (1960).

[2] G. C. Richey, R. H. Hobbs, and R. D. Stiehler, "Temperature Studies of the Air in a Truck Tire," *Rubber Age*, 79, 274 (1956); and "Direct Measurement of Tire Operating Temperatures," *NBS Tech. News Bull.*, 41, 76 (1957).

Variable-Camber Propeller

HAMILTON STANDARD has been awarded a U. S. Navy contract to develop a variable-camber propeller for aircraft. Next to size, the camber of a propeller blade is the most important single factor in determining its lift. The propeller would be the first ever to adjust the camber, or surface curvature, of its blades to increase or decrease lift to provide the most efficient level for any flight condition. It could add significantly to the climb and take-off performance of many aircraft, while maintaining high efficiency for cruise.

It would thus avoid the compromise of efficiency between the requirements for take-off versus cruise operations embodied in all of the current designs of propeller blades.

William E. Diefenderfer, engineering manager of Hamilton Standard, said the new propeller promises increases of up to 30 per cent in the range of high-speed transports and gains of as much as 50 knots in the speed of low-level attack planes. For long-range, endurance aircraft take-offs with heavy fuel loads would be possible even from short runways, with endurance improved as much as 20 per cent. In the case of future vertical take-off aircraft, the propeller might mean payloads half again as big as those now envisaged.

The variable-camber propeller would use six or eight blades mounted in sets of two on a common hub, with the near blades staggered behind the front ones. Each pair of front and rear blades would create a single airfoil surface similar to an airplane's wing with its flaps extended.

To change camber, the propeller would automatically alter the angles at which the front and rear blades meet the air. Since the two blades are in effect one surface, this change of angle would vary the over-all camber of the blades, just as a wing's curvature changes when the flaps go down. The result would be to increase or decrease lift.

The new propeller has already undergone extensive wind-tunnel tests in United Aircraft's Research Laboratories at East Hartford, Conn. Under the Navy contract, the government will fund further research of blade aerodynamic performance and the development of structural design, which are the first steps toward a flight article. A full-scale prototype of the propeller is scheduled to be ready in about nine months.

Largest Computer Yet

A STRETCH-CLASS computer, the most powerful and versatile data-processing system in the world, will be installed on the United Kingdom Atomic Energy Authority's system in late 1961. It will be 75 to 100 times more powerful than the large-scale IBM 709 which is at present in use by UKAEA. The contract was made with IBM World Trade Corporation through IBM United Kingdom Ltd.

Occupying the same floor space as a 709, Stretch can perform well over 1,000,000 logical operations per sec and complete more than 100 billion arithmetic operations in a single day.

The system to be delivered to the AEA will also have random-access disk-storage units capable of transferring one word every 8 microsec, six magnetic-core storage units with retrieval time of 2.18 millionths sec, and a vast magnetic-tape backing store.

SNAP-10's nuclear core is in two halves. Bringing them together results in sustained nuclear fission.

Nuclear Briefs

▶ SNAP-10 to Be Homogeneous Auxiliary Power Reactor

CRITICALITY experiments to obtain physics data for a complete reactor system have been made with the core for SNAP-10. One of the family of small reactors in the AEC program of Systems for Nuclear Auxiliary Power for space vehicles, the 300-watt SNAP-10 is being developed by Atomics International, a division of North American Aviation, Inc., Canoga Park, Calif.

The complete system, in which thermocouples for direct conversion of electricity will surround the nuclear core, will be tested early next year. Electricity will be generated by the flow of heat from the reactor through the thermocouples. Excess heat will be radiated to the atmosphere by fins.

Fuel and moderator are a homogeneous mixture of U-235 and zirconium hydride. Core is 7 in. high, 7 in. diam, $^1/_5$ cu ft volume, and weighs less than 200 lb.

The heat-conduction and reflector units are made of beryllium. The device is divided into two identical units which were brought together by remote control to achieve a sustained chain reaction. Each half was built up with alternate layers of fuel-moderator disks and circular conduction plates within a reflector.

▶ U. S. and Canada Plan Expanded Heavy-Water Program

Atomic Energy of Canada Limited and the U. S. Atomic Energy Commission have signed a memorandum of understanding providing for an expanded program of co-operation in the development of heavy-water-moderated power reactors.

Both Canada and the U. S. have under way broad research and development programs on heavy-water-reactor technology. The Canadian program includes construction of a prototype, 20-emw power station, NPD, and a full-scale, 200-emw power station, CANDU, both incorporating heavy-water reactors. A research and development study is being made to determine the feasibility of constructing a prototype, 40-tmw organic-cooled, water-moderated reactor.

Under the U. S. program are the construction of a prototype, 17-emw, power station (Carolinas Virgina) incorporating a heavy-water-moderated reactor; a heavy-water-moderated, plutonium-recycle, test reactor, PRTR; and a heavy-water components test reactor, HWCTR. Research and development are also under way to determine the economic feasibility of building a prototype 50-emw reactor.

▶ Gas-Cooled Reactor Experiment Attains Full Power

The Gas-Cooled Reactor Experiment, GCRE-1, has achieved full-power operation at the National Reactor Testing Station in Idaho.

Operated at 1850 tkw for 48 hr, it was then shut down for experimental purposes. The reactor heat will be dissipated in a water cooling tower with no provision for the generation of electricity.

The GCRE-1 is part of an over-all research and development program being conducted by Aerojet-General Corporation under contract to the Atomic Energy Commission and the U. S. Army Corps of Engineers, to provide a mobile nuclear power plant for the Department of Defense. Operation of a prototype of this power plant which will be known as the Mobile Low-Power Nuclear Power Plant No. 1, ML-1, is scheduled for next year.

The ML-1, transportable in four packages totaling less than 38 tons, combines the gas-cooled reactor system with a direct and closed-cycle gas-turbine-driven power-conversion system. The plant will generate about 300 net ekw and when fully developed will operate at least 1 yr at full power without refueling. The power plant is designed to be operable 12 hr after delivery at a site. Adequate shielding will permit relocation 24 hr after shutdown.

▶ Low-Power Assembly for MGCR Operates

A low-power nuclear assembly designed to provide essential physics data for the Maritime Gas-Cooled Reactor, MGCR, has achieved its first chain reaction at General Dynamics Corporation's John Jay Hopkins Laboratory for Pure and Applied Science.

The MGCR system would combine a high-temperature gas-cooled reactor and closed-cycle gas-turbine power machinery in one system. Using a beryllium-oxide moderator, uranium-oxide fuel, and helium coolant, the MGCR has a potential over-all efficiency of up to 40 per cent, while also making possible low fuel costs and a safe and compact design.

▶ Yankee Nuclear Power Plant Achieves Criticality

The Yankee Atomic Electric Company's 134,000-ekw pressurized nuclear power plant near Rowe, Mass., has achieved criticality. Routine full-power operation is scheduled to begin later this year.

The company was organized in 1954 by 11 New England electric utilities and arranged the financing of the entire capital cost of this project, estimated to by approximately $57 million. The AEC has provided $5 million in research and development assistance for the project and will waive fuel-use charges valued at about $3 million during the first 5 yr of plant operation.

Construction started in November, 1957, was completed on schedule on July 7, 1960.

Westinghouse Electric Corporation, Pittsburgh, Pa., and Stone & Webster Engineering Corporation, Boston, Mass., were prime contractors.

Materials Briefs

▶ High-Temperature Refractory

A NEW high-temperature refractory product, known as Crystolon 63, has been developed by the Norton Company, Worcester, Mass. It is expected to have wide application as a relatively low-cost structural ceramic, high in physical strength and in resistance to attack by heat and molten salt. It has already been used experimentally as a lining in aluminum-reduction cells and test results indicate that wall thickness of the cell linings can be reduced about 75 per cent. In addition, substantially less electric power is required.

Crystolon 63 is a silicon-nitride-bonded refractory. While it was originally developed to meet the need for better refractory linings for aluminum-reduction cells, it is suitable for use in such other applications as melting and alloying high-purity, expensive metals; transferring molten materials; as structural ceramic for package boilers, incinerators, and in kiln furniture.

Silicon-carbide refractories are characterized by high thermal conductivity, excellent heat-shock properties, and good resistance to most corrosive liquids. Silicon-carbide grain itself shows very little or no deterioration upon exposure to many molten metals and fused salts. For example, when silicon carbide contacts fused cryolite, which is the fluoride electrolyte used in the electrochemical production of aluminum metal, it exhibits excellent corrosion resistance.

The material used to bond the silicon carbide determines the limit of use of the refractory. The conventional bond is an oxide or a silicate. Since fused salts, such as cryolite, are solvents for most oxides, this type of bond does not stand up. Also, metals such as aluminum and magnesium reduce and wet oxide bonds to some extent. Silicon nitride bonds, however, exhibit excellent resistance to attack under this same condition.

▶ A36, Higher-Yield-Point Structural Steel

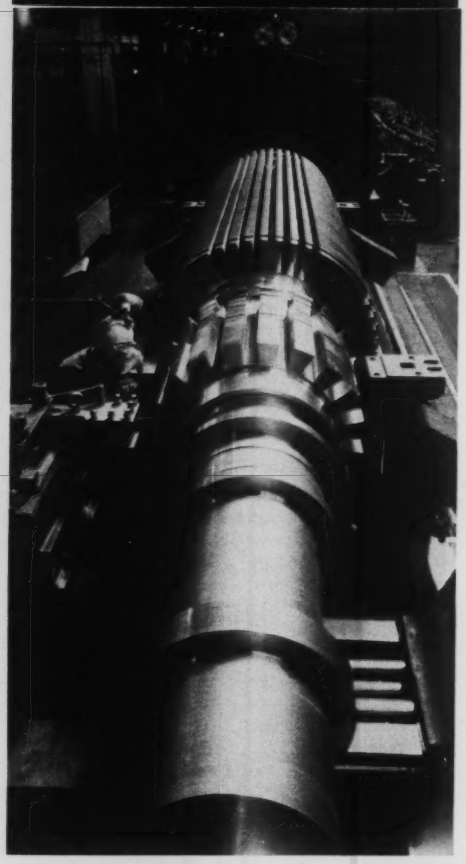
AVERAGE savings of 4 to 6 per cent in the weight of steel structures are promised by a new and higher-yield-point structural carbon steel. The new steel made by the United States Steel Corporation conforms to the recently approved ASTM specification A36-60T for rolled structural steel. Because of its higher minimum yield point, A36 is expected to become the dominant steel used in structural applications.

ASTM A7 and ASTM A373 have long been considered as standard in the heavy construction field; ASTM A7 generally being used for bridges, buildings, and other structural applications where load-bearing members are bolted or riveted, and ASTM A373 being used primarily in welded construction. Their minimum yield points are 33,000 and 32,000 psi, compared with 36,000 psi for A36. On an equal weight basis, A36 will withstand about 10 per cent greater load in tension than A7 before it reaches its yield point and about 12 per cent greater than weldable A373 grade. Moreover, according to United States Steel, A36 compares favorably with A373 from a weldability standpoint.

A36 is available in structural shapes, plates, and bars—the full product line now rolled by United States Steel to the A7 and A373 specifications.

All in all, the "cost-to-strength ratio" of the new steel is substantially better than for existing carbon structural steel specifications and cost savings should result from its use.

Giant Lathe. At Allis-Chalmers West Allis Works, this 75-ton nickel-molybdenum steel forging is being machined on a 144-in. engine lathe, one of the largest ever made. The lathe measures 60 ft between centers. The forging is for a 4-pole generator rotor.



MACHINE TOOLS
in the news

Milling and Profiling. At the September Machine-Tool Show in Chicago, this tape-controlled milling and profiling machine was shown by Ekstrom, Carlson & Company of Rockford, Ill. All the way surfaces are protected by wipers and covers. "Human-factors engineering" minimizes possibility of operator error.

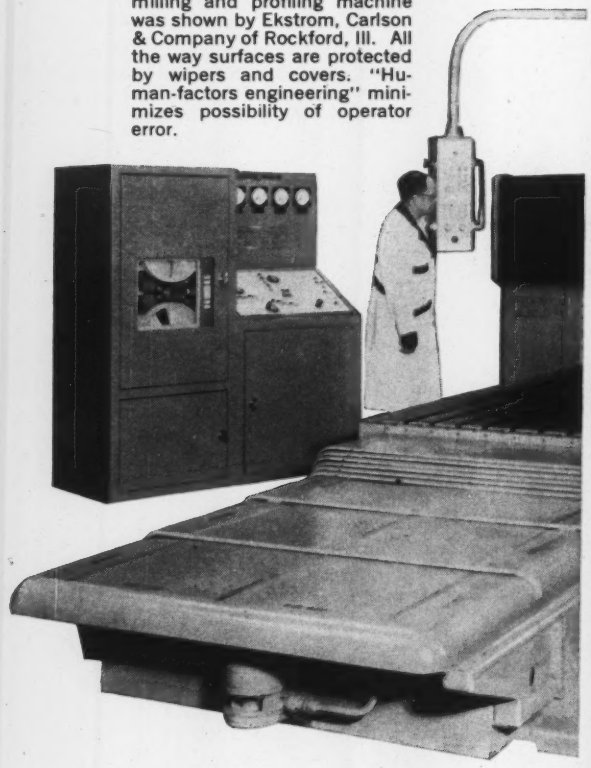
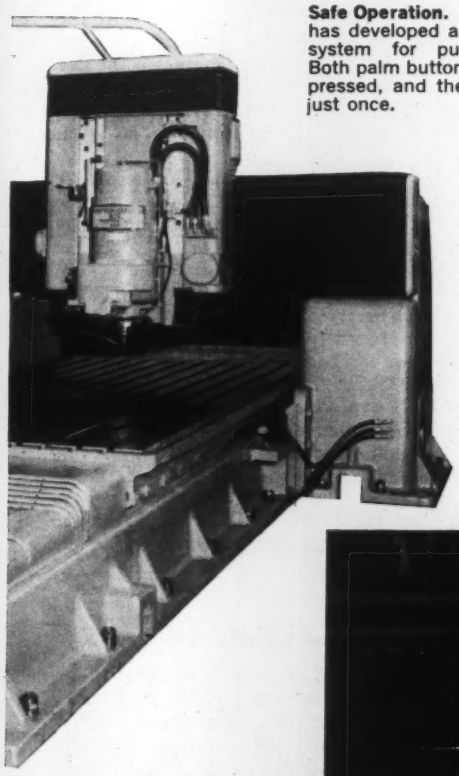


PHOTO BRIEFS

M. BARRANGON

Gear Cutting. This may be the world's largest generated, single-helical split ring gear. Farrel - Birmingham Company, Inc., of Buffalo, N. Y., cut four of these gears on a big gear generator, a type which they design and manufacture. The alloy cast-steel gears have a diam of 23 ft, with 30-in. face width. Finished weight is 85,000 lb.

Safe Operation. Westinghouse has developed a dual-interlock system for punch presses. Both palm buttons must be depressed, and the press cycles just once.



Taper. To machine this 33-ton, hard-surfaced bell (for a blast furnace), R. C. Mahon Company's Steelweld Division used a double-duty machining head especially designed for a 53-deg taper. As shown, it is holding a 14-in. grinding wheel to obtain an 8-microin. finish on the hardened seating area.

Engineering Progress in the British Isles and Western Europe

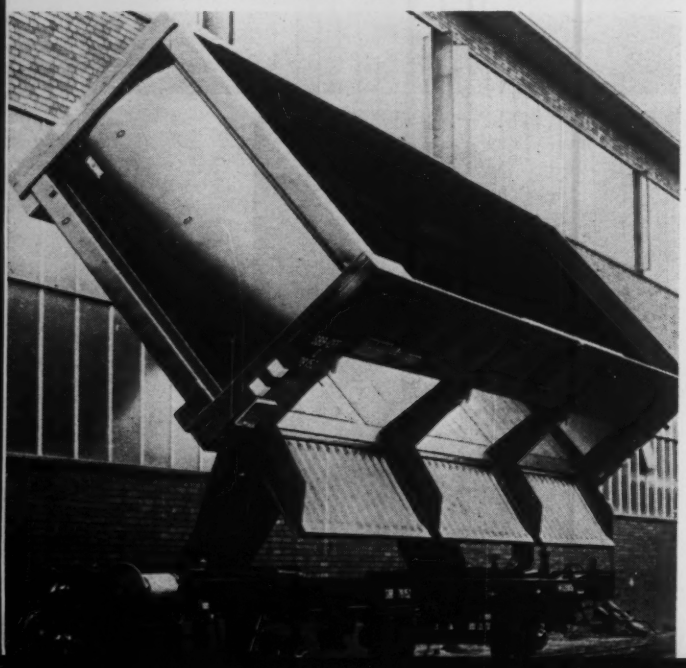
J. FOSTER PETREE
European Correspondent

EUROPEAN SURVEY

Lifting and Tipping Dump Car

A PROMINENT exhibit at the recent German Industries Fair at Hanover was a rail dump car in which the entire body is lifted off the frame and tipped hydraulically to either side. Developed by the Rheinstahl Siegener Eisenbahndedarf A.G. (SEAG), of Dreis-Tiefenbach, Siegen, Germany, in collaboration with the German Federal Railways, it is being used also by the Swiss Railways, which exhibited one of these cars at the Swiss Industries Fair. A hydraulically operated toggle mechanism, working on slides within the car frame, raises the body vertically, and subsidiary rams are then used to effect the tipping. Opening and closing of the side doors are done hydraulically. The hydraulic mechanism is electrically driven, taking current from any convenient source, the power unit being designed for three-phase current at from 220 to 380 volts. The body can be raised 1.60 m (5 ft 2 3/4 in.) and can be stopped and tipped at any point up to its maximum elevation. The side doors are in three sections, each of which can be operated independently and used to control the rate of discharge. The empty weight is 13.5 metric tons and the capacity is 26.5 metric tons. It is understood that arrangements have been made to try out cars of this type on an American railroad and there is a possibility that they may be constructed in the United States under license.

SEAG lifting and tipping dump car in use on German and Swiss railways



Brake-Disk Grinding Machine

A MACHINE for simultaneously grinding both faces of brake disks has been developed by the Lumsden Machine Company, Ltd., Hawks Road, Gateshead, England, and is being marketed by Alfred Herbert, Ltd., Red Lane Works, Coventry, England. The disk is held on a rotating spindle and the disk faces are ground by the peripheries of two grinding wheels, 24 in. diam and of a suitable width, which may be from 2 in. to 3 3/4 in. The machine has two work spindles carried on an indexing drum, so that while one disk is being ground the other spindle can be loaded. The wheels retract to allow the entry of the disk, and hydraulically operated diamond dressers trim them at preset intervals to maintain the size and finish. The drum carrying the spindles reciprocates slightly during grinding to insure that trueing marks are not reproduced on the work. Disks from 9 in. to 14 in. diam can be ground.

The work spindles revolve at 36 rpm and the grinding wheels at speeds from 750 to 870 rpm, according to the size of the work. The drive to the wheel spindles is by a 15-hp electric motor, running at 1000 rpm. The feed of the grinding heads is infinitely variable between 0.004 in. and 0.030 in. per min, and the setting of the wheels is adjustable by a handwheel. The rate of dresser traverse also is infinitely variable between 2 in. and 30 in. per min, and the depth of dressing can be set at ten rates from 0.0002 in. to 0.002 in. The frequency of dressing is normally at one of six available rates, from every second disk to every 24th, but other ranges can be provided if required. The individual diamonds are also adjustable by means of a graduated knob that advances the diamond by 0.005 in. for one turn. Two extra wheel mounts are supplied with the machine so that replace wheels may be mounted on them and dynamically balanced while the working wheels are in use.

Shoulder Grinding to Fine Limits

Two Swiss firms, F. Studer Ltd., of Glockenthal-Thun, and Movomatic Ltd., of Neuchatel, have collaborated in the design of a machine for the accurate production of shoulder distances on a quantity basis, without reference to a second dimension. Examples of the kind of work for which it is intended: The manufacture of high-precision valves; and the production of a controlled matching or overlapping between shoulders on the valve and

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ports in the valve sleeve, for such applications as the hydraulic operation of machine tools. It is stated that shoulder distances up to 4.7 in. can be produced within an accuracy of 0.001 mm.

In operation, a master component is first inserted between the machine centers, and the fingers on the measuring head are brought into contact with it. The indicator instrument is then set to zero and the operating relays are set to act at the required points on the indicator scale.

The coarse and fine feed potentiometers having been set, the master component is removed and the workpiece inserted in its place. The wheelhead is brought forward by the hand lever on the front of the machine and automatically approaches a fixed stop as the work begins to rotate. Thereafter the fingers on the measuring head actuate the controls until the predetermined dimensions are reached.

Internal work can also be undertaken, such as the grinding of two internal circumferential grooves or cannelures inside a sleeve, at a set distance apart. For such applications, special internal types of measuring heads are provided.

Supercritical Pressure Generators

The Central Electricity Generating Board, the agency responsible for the provision of equipment for Britain's electric power supply, has decided to install two steam generators to work at supercritical pressure in their Drakelow C power station, near Burton-on-Trent, England.

One is to be built by Babcock & Wilcox, Ltd., Renfrew, Scotland, and the other by International Combustion, Ltd., Derby, England. Together they will cost, with their associated turboalternators, about $40 million (£15m). The steam conditions are specified as 3500 psi at the turbine stop valve, and 1100 F. After partial expansion the steam will return to the boiler to be reheated to 1050 F before re-entering the turbine to be expanded to vacuum. At full load each boiler will consume about 150 tons of coal per hr. The turboalternators will be single-shaft machines, with an output of 375,000 kw, and will be built by Associated Electrical Industries, Ltd., Manchester, and the English Electric Co., Ltd., Stafford, each firm undertaking one complete unit.

Drilling an Emergency Pipe Lead

The Atlas Copco Company, the Swedish makers of compressed-air plant and mine-drilling equipment, were faced with an unusual problem when the fuel-oil pipes to the central-heating plant of a shoe factory in Essen, Germany, burst near the boilers and flooded the boiler room with oil. The building was a large one, with a basement floor at a level some feet below ground, a subbasement beneath it, and the central heating plant in a cellar below the subbasement. The oil-fuel tank was outside the building, in a pit below the level of the basement floor.

The problem was to put in new pipes from the tank to the boilers. To have followed the line of the old pipes would have meant digging through a heavy paved floor, a considerable thickness of brickwork, a 20-in. layer of concrete, and about 23 ft of earth.

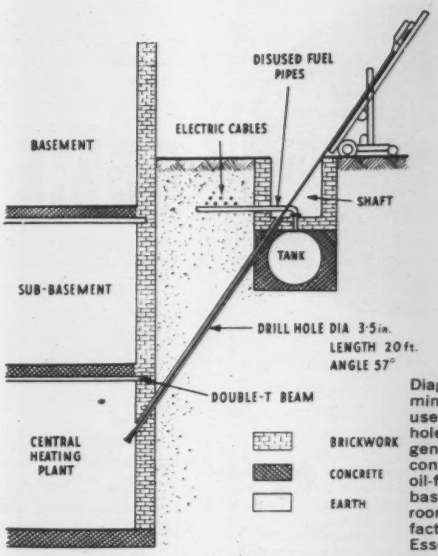


Diagram of mining drill used to make hole for emergency pipe connection to oil-flooded basement boiler room of a shoe factory in Essen, Germany

The Atlas Copco solution was to bring up one of their BVB 23 wagon drills, which can drill to any angle over an arc of 130 deg and to a depth of 100 ft. To avoid electric cables, the location of which was not precisely known, the rig was positioned outside the building and a hole drilled at an angle of 57 deg from the tank pit through its brick floor and the concrete enclosing the tank, thence through earth, and finally through the brick wall of the building into the heating-plant room. The hole was $3^1/_2$ in. diam and 20 ft long and took two hours to drill, the whole operation taking only six hours.

The Atlas Copco BVB 23 wagon drill begins operations outside the Essen Shoe Factory. A hole was drilled at an angle of 57 deg from the oil fuel tank installed under the building to the basement so that new pipes to replace those that had burst could be fitted with a minimum of disturbance.

Substance in Brief of Papers Presented at ASME Meetings

ASME TECHNICAL DIGEST

Heat Transfer

Heat Transfer From Humid Air to Fin and Tube Extended Surface Cooling Coils.. 60—HT-17... By Chester D. Ware and Thomas H. Hacha, Assoc. Mem. ASME, LaCrosse, Wis. 1960 ASME-AIChE Heat Transfer Conference paper (multilithographed; available to June 1, 1961).

The determination of cooling coil performance is a relatively simple matter when the air is sensibly cooled on a dry coil surface and accurate heat-transfer coefficients derived from tests are available. However, in the majority of cooling coil applications it is required to dehumidify as well as cool the air. This requirement considerably complicates the problem. Since both heat and mass transfer must be considered, the equations are more complex.

In a cooling coil, the air dry and wet bulb temperatures and refrigerant temperatures vary as the air is being cooled. Consequently, the temperature of the coil surface also varies throughout the coil. The determination of this varying surface temperature is the major difficulty in the accurate prediction of dehumidifying coil performance.

The authors attempt to develop a new approach to the solution of problems involving heat and mass transfer from air to extended surface cooling coils that will yield accurate results over a large range of air-conditioning problems by utilizing heat-transfer data derived from sensible heat-transfer tests. Although the final relations are not in a form that facilitates ease in application, they are the basis for further simplification to be presented in a later paper.

Efficiency of Finned Annular Passages.. 60—HT-3... By Allan D. Kraus, Assoc. Mem. ASME, Sperry Gyroscope Company, Great Neck, L. I., N. Y. 1960 ASME-AIChE Heat Transfer Conference paper (multilithographed; available to June 1, 1961).

In considering heat-exchange surface for air-borne applications, the designer must keep in mind the ideal of minimum weight and volume. While the tendency has been toward the use of the so-called "compact" heat exchangers, it is possible that the finned double-pipe exchanger has installation advantages in certain applications.

In order to utilize the surface of the outer pipe, it would appear desirable and feasible to attach the fins to both the inner and outer pipe. The efficiency for the entire configuration must be evaluated since the customary hyperbolic tangent relationship for the longitudinal fin will no longer be valid.

A derivation for the efficiency of the double-pipe exchanger with the fins attached to both the inner and outer pipe walls is presented. For an assumed set of conditions, this configuration is then compared to a finned annulus with fins attached to inner pipe only and then to a simple double-pipe annulus with no fins. The comparison indicates a significant improvement over the bare and finned inner-tube arrangements.

Thermal-Conductivity Studies With the Powell Method..60—HT-30... By A. I. Dahl and D. W. Jones, General Electric Company, Schenectady, N. Y. 1960 ASME-AIChE Heat Transfer Conference paper (multilithographed; available to June 1, 1961).

Thermal conductivity is one of the important properties that must be considered in evaluating materials for special engineering applications. Conventional methods of measuring thermal conductivity are usually time-consuming and require special sample preparation.

R. W. Powell has described a method of measuring thermal conductivity which greatly minimizes the problems of sample preparation and time required for conducting a test. The authors present the results of an experimental study with the Powell system and an analysis of the heat-transfer phenomena involved.

In Powell's apparatus, two similar metal spheres are mounted in a block of balsa wood such that one sphere is recessed just within the surface, while the other projects slightly beyond the surface. When the device is placed in contact with the material under test, one of the spheres makes physical contact with the material, while the other does not. The rate of decrease in temperature of the contacting sphere as compared to the noncontacting sphere is a measure of the thermal conductivity of the test material.

Wall Temperature and Heat Flux Measurement in a Round Tube..60—HT-1 ... By A. I. Morgan, Jr., and Robert A. Carlson, Western Regional Research Laboratory, Albany, Calif. 1960 ASME-AIChE Heat Transfer Conference paper (in type; to be published in **Trans. ASME—J. Heat Transfer;** available to June 1, 1961).

An experimental method of measuring the mean temperature and heat flux into or out of any region along a circular metal tube is described.

This is accomplished by converting the tube itself into a series of resistance thermometers. When the tube conducts direct current, each thermometer measures the tube temperature which is a mean of both radial and longitudinal variations within its region. When alternating current flows, the thermometers still average longitudinal variations.

Because of the skin effect, however, the a-c impedance better reflects the temperature of the outer surface of tube at the expense of the inner surface. Thus the d-c resistance yields the average tube temperature, and comparison of the d-c resistance and a-c impedance yields the heat flux through the metal. Of course, these two measurements make possible calculation of the temperature of either surface of the tube.

The original impetus for this research lay in the need for a fundamental study of fouling on heat-transfer surfaces. Fouling is particularly expensive to the food processing industry, which frequently

uses stainless-steel surfaces. Fouling problems result inevitably from the combination of heat sensitive materials with heated surfaces of low thermal conductivity, such as stainless steel.

Temperature Regulation in a Bio-Satellite..60—HT-6... By K. L. Cappel, The Franklin Institute Laboratories for Research and Development, Philadelphia, Pa. 1960 ASME-AIChE Heat Transfer Conference paper (multilithographed; available to June 1, 1961).

The temperature in the life cell of an orbiting satellite carrying two individually confined white rats must be maintained at 20 C ± 3 deg.

A simple off-on temperature-regulating system is proposed which, by shifting a slotted cylindrical shield, exposes to space one of two sets of radiating surfaces. One set has a high, and the other a low ratio of solar absorptivity to emissivity in the infrared, thus permitting either a low or a high rate of rejection by radiation of the heat generated by the animals, the chemicals used to absorb carbon dioxide and water, and the electronic equipment.

Emphasis is placed on temperature changes in the animal chamber under extreme conditions of external heat absorption or rejection by radiation, rather than on the effects on the heat balance of such variables as inclination and eccentricity of the orbit; time of day, month and place of launching; attitude, spin rate, and so on.

It is assumed that a thermal control scheme that performs satisfactorily under the most extreme conditions will probably be suitable under any combination of the variables mentioned. The life-cell temperature of an idealized system is determined for a number of combinations of steady-state heat inputs, for both positions of the movable shield.

The Viscosity of Steam and Water at Moderate Pressures and Temperatures.. 60—HT-29... By J. R. Moszynski, Case Institute of Technology, Cleveland, Ohio. 1960 ASME-AIChE Heat Transfer Conference paper (multilithographed; available to June 1, 1961).

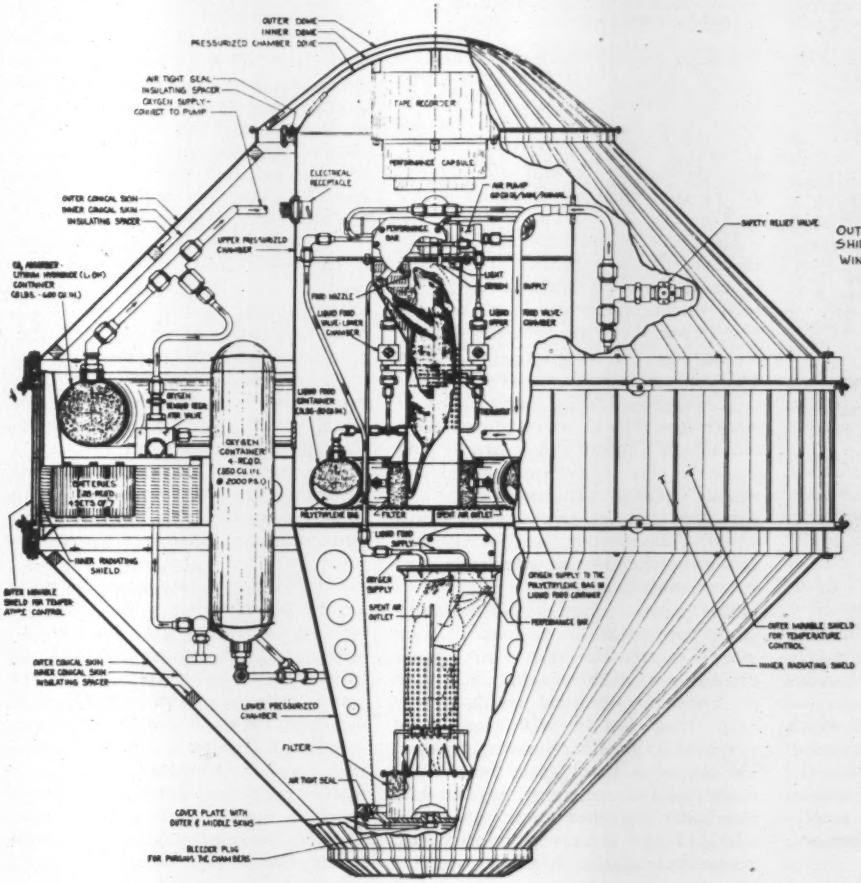
The results of an investigation of the viscosity of steam and compressed water are reported. The measurements were carried out by means of an oscillating-body-type viscometer, in order to develop an alternative method of measurement to the usually employed capillary viscometer and also to provide an independent check on published data.

The results for compressed water, obtained with the aid of an oscillating sphere, represent absolute measurements, and cover a range from 3 to 340 atm and from 20 to 186 C.

The viscosity of water is shown to have a negative pressure coefficient below 35 C and a positive coefficient above that temperature. The maximum change in viscosity at any given temperature over the pressure range covered is 5 per cent.

The results show good agreement with previously published data and the deviations of experimental points from smoothed curves do not exceed 0.05 per cent.

Although the present instrument is severely limited in range, the feasibility of measurements at elevated temperatures and pressures by means of the oscillation-type viscometer is clearly demonstrated. Particularly striking is the reproducibility and self-consistency of the results obtained.



Arrangement of bio-satellite carrying white mice. **Above** is a configuration of the thermal system with conical shields removed, showing the life cell. Radial ribs cantilevered from the middle of the life cell support the narrow cylindrical shield, which is partially covered with vertical stripes of aluminum oxide paint. A second movable shield has openings that may be shifted to expose or cover the aluminum stripes (60—HT-6).

Thermal Conductivity and Prandtl Number of Carbon Dioxide and Carbon-Dioxide Air Mixtures at One Atmosphere..60—HT-13...By Jerome L. Novotny, University of Minnesota, Minneapolis, Minn.; and Thomas F. Irvine, Jr., Mem. ASME, North Carolina State College, Raleigh, N. C. 1960 ASME-AIChE Heat Transfer Conference paper (in type; to be published in **Trans. ASME—J. Heat Transfer;** available to June 1, 1961).

By measuring laminar recovery factors in a high velocity gas stream, experimental determinations were made of the Prandtl number of carbon dioxide over a temperature range from 285 to 450 K and of carbon-dioxide air mixtures at an average temperature of 285 K with a predicted maximum error of 1.5 per cent. Thermal conductivity values were deduced from these Prandtl numbers and compared with literature values measured by other methods.

Using intermolecular force constants determined from literature experimental data, viscosities, thermal conductivities, and Prandtl numbers were calculated for carbon-dioxide air mixtures over the temperature range 200 to 1500 deg for mixture ratios from pure air to pure carbon dioxide.

An important parameter in convective heat transfer is the Prandtl number, which contains two transport properties, thermal conductivity and dynamic viscosity.

Applied Mechanics

A Study of the Stability of Externally Pressurized Gas Bearings..60—APM-5...By Lazar Licht, Assoc. Mem. ASME, The Franklin Institute, Laboratories for Research and Development, Philadelphia, Pa.; and Harold Elrod, Assoc. Mem. ASME, Columbia University, New York, N. Y. 1960 ASME Summer Conference of the Applied Mechanics Division paper (in type; to be published in **Trans. ASME—J. Appl. Mech.;** available to April 1, 1961).

Externally pressurized gas bearings, unlike those using incompressible fluids, are characterized by their unstable behavior, which is discussed here.

The pertinent equations of motion are linearized and the stability criteria stated in terms of small deviations from the equilibrium operating point. The flow in the bearing clearance is treated on a distributed rather than on a lumped-parameter basis.

Results obtained from present analysis when compared with those previously arrived at by means of simplified analyses show a marked divergence in the limiting values of parameters which influence the stability of the bearing. These results and divergences are discussed in terms of permissible compression volume, pressure ratios, supply-nozzle size, length of annular clearance, and bearing mass.

The Vibration Response of a Linear Undamped System Resting on a Nonlinear Spring..60—APM-6...By P. R. Paslay and M. E. Gurtin, Assoc. Mems. ASME, General Electric Co., Schenectady, N. Y. 1960 ASME Summer Conference of the Applied Mechanics Division paper (in type; to be published in **Trans. ASME—J. Appl. Mech.;** available to April 1, 1961).

The steady-state, undamped-displacement-amplitude response of a linear system on a single nonlinear spring due to a force excitation which varies sinusoidally with time is investigated. The force-displacement relation of the spring is

$$F = k(x + \epsilon x^3)$$

The Fourier component of the displacement-amplitude response of the system at the forcing frequency and its third harmonic are considered.

Prediction of Creep Failure Time for Pressure Vessels..60—APM-7...By F. P. J. Rimrott, Mem. ASME, University of Toronto, Toronto, Canada; Earl J. Mills, Assoc. Mem. ASME, Battelle Memorial Institute, Columbus, Ohio; and Joseph Marin, Mem. ASME, Pennsylvania State University, University Park, Pa. 1960 ASME Summer Conference of the Applied Mechanics Division paper (in type; to be published in **Trans. ASME—J. Appl. Mech.;** available to April 1, 1961).

When a pressure vessel is subjected to internal pressure and is made from a material which exhibits creep, the vessel will expand. If the internal pressure is held constant during expansion, the load on the wall will increase. At the same time, the thickness of the wall decreases.

The result of these two simultaneous effects is that the expansion of the vessel is continuously accelerated until the wall thickness has decreased and the load increased to such an extent that the strength of the material is no longer sufficient and fracture occurs.

The time-to-fracture in the case of simple tensile creep was predicted theoretically by Orowan and shown by Hoff to be in good agreement with experimental results. The basis of their approach is to use true stress and true strain. The creep-failure time is then defined as the time at which the true strain reaches infinity.

The present paper extends the foregoing concept to the problem of combined stresses. The creep-failure time is determined for thin, thick, and very thick-walled cylindrical vessels of circular cross section with closed ends subjected to constant internal pressure. The theory is based upon common assumptions for predicting creep deformation under combined stress. A power relation is used to express the creep rate versus stress relation in simple tension.

Sinusoidal Excitation of a System With Bilinear Hysteresis..60—APM-8...By T. K. Caughey, California Institute of Technology, Pasadena, Calif. 1960 ASME Summer Conference of the Applied Mechanics Division paper (in type; to be published in **Trans. ASME—J. Appl. Mech.;** available to April 1, 1961).

Many physical systems exhibit hysteresis which may be adequately described by a bilinear hysteresis model.

The response of a single-degree-of-freedom oscillator, having bilinear hysteresis, to sinusoidal excitation, is analyzed, as well as the stability of the resulting motion in the case of weak damping.

It is shown that the system exhibits a soft-type resonance with stable, single-valued response curves, and that for such a system there exists a critical value of the excitation, above which unbounded resonance occurs.

Stability of a Turbine-Generator Rotor Including the Effects of Certain Types of Steam and Bearing Excitations..60—APM-9...By A. H. Landzberg, Assoc. Mem. ASME, Mohansic Laboratory, Yorktown Height, N. Y. 1960 ASME Summer Conference of the Applied Mechanics Division paper (in type; to be published in **Trans. ASME—J. Appl. Mech.;** available to April 1, 1961).

The problem of rotor instability has been a troublesome one for many years in the design of steam turbine-generator rotors. There have been many instances, in which rotors have been found to vibrate with large amplitudes at or near the so-called "first turbine critical speed," while the rotation velocity was considerably higher.

A problem of vibration instability, it has been solved in the past in a practical way by making design and operating modifications which usually result in a change in critical speed and/or in an increase in bearing damping.

Most investigations of rotor instability have been concerned with "oil whip," both the critical-speed type and the half running-speed type.

This paper is concerned with the extension of previous work on oil whip to include the actual dynamic characteristics of an entire turbine-generator rotor.

The effects of certain steam forces and bearing oil-film forces on vibration stability of a turbine-generator rotor are considered. A matrix method for systematically calculating the characteristic equation of a real rotor is developed with the aid of complex notation.

A sample problem concerning a simple shaft with symmetrical vibrations is worked out and the results are compared to those obtained by another author. Complete agreement is obtained in the determination of the equation.

Note on the Assessment of Flow Disturbances at a Blunt Body Traveling at Supersonic Speeds Owing to Flow Disturbances in Free Stream..60—APM-10... By M. V. Morkovin, Mem. ASME, The Johns Hopkins University, Baltimore, Md. 1960 ASME Summer Conference of the Applied Mechanics Division paper (in type; to be published in **Trans. ASME—J. Appl. Mech.**; available to April 1, 1961).

When a strong shock wave is perturbed from its equilibrium configuration, the field downstream of the shock can be thought of as being composed of the original field plus perturbation fields of (*a*) entropy, (*b*) vorticity, and (*c*) pressure and irrotational velocity ("sound").

To assess the magnitude of flow disturbances that would affect conditions on a blunt nose of a body moving at supersonic speeds, the detached shock is approximated by a purely normal shock. The disturbances downstream of the shock are expressed in terms of the "free-stream" disturbances by considering sinusoidal fluctuations.

Pressure fluctuations generated by interactions of entropy-temperature disturbances with the normal shock may be considerable at high Mach numbers, but their effect on the transition of a laminar boundary layer to a turbulent one is a matter of speculation. However, conjectures that reflections of such pressure waves between the body and the shock wave might lead to high resonant amplifications are disproved.

On Saint Venant's Principle: Elastic Shells and Plates..60—APM-11... By P. M. Naghdi, Mem. ASME, University of California, Berkeley, Calif. 1960 ASME Summer Conference of the Applied Mechanics Division paper (in type; to be published in **Trans. ASME—J. Appl. Mech.**; available to April 1, 1961).

The validity of Saint Venant's principle in the theory of thin elastic shells and plates is examined.

Following some preliminaries which include a brief discussion of the validity of the reciprocity theorem for Love's theory, an integral formula is established for the displacements and their partial derivatives at an arbitrary fixed point of the shell middle surface.

The conclusions reached may be roughly stated as follows: If the loads acting on the shell maintained in equilibrium are purely edge loads, then the orders of magnitude of the displacements and stresses are in accord with the traditional statement of Saint Venant's principle. On the other hand, if the loads on the shell are purely surface loads, then the conclusions concerning the orders of magnitude of the displacements and stresses are the same as those of the modified Saint Venant's principle.

On Three and Two-Dimensional Disturbances of Pipe Flow..60—APM-12... By Kurt Spielberg, The City College, New York, N. Y.; and Hans Timan, University of Vienna, Vienna, Austria. 1960 ASME Summer Conference of the Applied Mechanics Division paper (in type; to be published in **Trans. ASME—J. Appl. Mech.**; available to April 1, 1961).

The transition of laminar to turbulent flow of a viscous, incompressible fluid has for a long time attracted attention. In particular, the effect of small, incidental disturbances on the main flow has been studied.

It is established that in the case of pipe flow a proof of stability against two-dimensional disturbances allows no final conclusion about the sensitivity against three-dimensional ones.

A system of ordinary, coupled differential equations is set up for three-dimensional disturbances of Poiseuille flow in a straight pipe of circular cross section. The commonly treated equations are shown to be special cases arising from particular assumptions.

It is shown that in the nonviscous, and therefore also in the general case, there exists, in contrast to the analogous problem in Cartesian co-ordinates, no transformation reducing the given problem to a two-dimensional one. A fourth-order differential equation is derived for disturbances independent of the direction of the main flow. The solutions obtained show that those two-dimensional disturbances, termed cross disturbances, decay with time and therefore do not disturb the stability of the main flow. Explicit expressions for the cross disturbances are obtained and a discussion of their nature is given.

An Approximate Analysis of the Influence of Aerodynamic Heating and Initial Twist on the Torsional Stiffness of Thin Wings..60—APM-13... By Lit S. Han, Ohio State University, Columbus, Ohio. 1960 ASME Summer Conference of the Applied Mechanics Division paper (in type; to be published in **Trans. ASME—J. of Appl. Mech.**; available to April 1, 1961).

A simple formula based on the "fiber-stress" concept is derived for calculating the thermally induced twist in a thin wing that has an initial twist about its axis. The problem of induced twists is related to the general problem of reduction of torsional stiffness. A general treatment of the influence of aerodynamic heating and the effects of initial twist on the torsional stiffness are given.

Criteria are established for calculating the critical temperature difference between the edges and the mid-chord position to prevent possible aeroelastic reversals or buckling. Formulas are valid for wings with large aspect ratios.

On The Airy Stress Functions of Plane Dislocation Problems..60—APM-14... By F. D. Ju, Assoc. Mem. ASME, University of New Mexico, Albuquerque, N. Mex. 1960 ASME Summer Conference of the Applied Mechanics Division paper (in type; to be published in **Trans. ASME—J. Appl. Mech.**; available to April 1, 1961).

The plane theory of elasticity has found wide application in many engineering problems, for which the problem of multiple-valued displacements has attained new significance. Its treatment, found in a number of elasticity textbooks, is based on the concept of the dislocation theory as introduced by Volterra.

In Volterra's theory, the dislocation cut connects two closed boundary curves. After rigid displacement, the two edges are joined again, resulting in a discontinuous displacement along the dislocation cut, while the stress components are continuous. This type of analysis does not apply to a certain class of problem when there is a dislocation cut which initiates from a boundary and ends in the material.

A more recent theory, permitting elastic deformation of both edges before joining, and relaxing the stress-continuity condition across the dislocation cut, introduces an elastic-dislocation concept. Thus it overcomes this restriction on the Volterra-type dislocation problem.

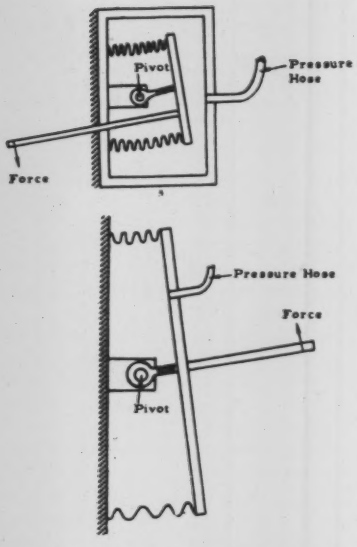
Through the use of complex-variable representation, this paper generalizes the application of the elastic-dislocation theory. It explores the Airy stress function of a doubly connected region with two shapes of dislocation cuts; an arbitrary straight cut and a logarithmic spiral cut.

For simplicity and illustrative purpose, only an infinite region with a circular hole has been considered. The inner boundary is a circle with center at the origin. The outer boundary is at infinity. The discussion deals with the singular point and the uniqueness of the general solution.

Forced Lateral Vibration of a Uniform Cantilever Beam With Internal and External Damping..60—APM-15.. By Ho Chong Lee, Rensselaer Polytechnic Institute, Troy, N. Y. 1960 ASME Summer Conference of the Applied Mechanics Division paper (in type; to be published in **Trans. ASME—J. Appl. Mech.**; available to April 1, 1961).

The steady-state response problem of a uniform beam with a sinusoidal shaking force at the base is studied for the case where the beam material is the general linear substance represented by a model having an additional spring element in parallel with the Maxwell elements.

In the analysis, the stress-strain relationship is applied only to the longitudinal strain of the beam, leaving the



Schematic diagrams of test setups for bending small bellows under external pressure **(above)**, and bending large bellows under internal pressure **(below)** (60—APM-16)

shear-strain relation to be that of a perfectly elastic material.

The exact solution with a numerical example is given for one case where the shear and rotatory inertia effects are neglected. This result is compared with the solution obtained by a tabular method. The results of both methods are in excellent agreement.

The Effect of Pressure on the Bending Characteristics of an Actuator System..60—APM-16... By Paul Seide, Assoc. Mem. ASME, Space Technology Laboratories, Inc., Los Angeles, Calif. 1960 ASME Summer Conference of the Applied Mechanics Division paper (in type; to be published in **Trans. ASME—J. Appl. Mech.**; available to April 1, 1961).

The fact that internal pressure may under certain circumstances contribute to or be the sole cause of buckling of cylindrical shells have appeared several times in technical literature, but the phenomenon has long escaped the attention of workers in the field, since large lengths and/or high pressures are required for buckling to occur.

Flugge, who deduced its existence in 1932, showed that for the stresses to remain elastic the length must be at least 50 cylinder radii, and cylinders of these dimensions are rare.

The present authors deal with a cantilevered bellows, the movable end of which is clamped to a rigid plate constrained by a rigid arm to rotate about a fixed point on the longitudinal axis of the bellows.

The effect of pressure and pivot-point location of the spring characteristics of the system is investigated. Variations in the pressure and pivot location are shown to cause significant changes in the characteristics of the system which affect the bellows design to a considerable extent. It is found that under internal pressure the system can become unstable for any location of the pivot point and under external pressure when the pivot point lies between the ends of the bellows.

Experimental results are given for two bellows, one internally pressurized and the other under external pressure. The comparison between theory and experiment is quite good for the bellows under external pressure, but poor for the other. A possible explanation of the poor agreement is given and the need for further testing is pointed out.

Buckling of Circular Cones Under Axial Compression..60—APM-17... By Leslie Lackman, North American Aviation; and Joseph Penzien, University of California, Berkeley, Calif. 1960 ASME Summer Conference of the Applied Mechanics Division paper (in type; to be published in **Trans. ASME—J. Appl. Mech.**; available to April 1, 1961).

Considerable discrepancy exists between experimental and theoretical buckling loads for cylindrical and spherical shells.

It is generally considered that local inaccuracies in shell geometry and applied loading play a most important part in this discrepancy, which is normally taken care of by multiplying the classical theoretical load based on small deflections and no defects by an experimental correction factor.

Results are presented of an experimental investigation to determine the buckling strength of right circular cones under axial compression. Correlation of these data is made with existing theory and with previously published experimental data on circular cylinder; and a recommended procedure for predicting the buckling load of right circular cones under the foregoing loading condition is presented.

The following conclusions are deduced:

1 The resultant elastic axial buckling load of right circular cones, loaded along their generator, can be predicted with reasonable accuracy using the given equation, and the corresponding correction factor.

2 The correction factor should be based on the true radius of curvature of the cone at its base rather than the true radius of curvature at mid-height.

3 The resultant elastic axial buckling load for fixed-ended, right circular cones can be predicted by the foregoing method provided the correction factor is based on data for fixed-ended cylinders rather than simply supported cylinders.

Modeling of Large Transient Elastic and Plastic Deformations of Structures Subjected to Blast Loading..60—APM-18... By W. E. Baker, Mem. ASME, Ballistic Research Laboratories, Aberdeen Proving Ground, Md. 1960 ASME Summer Conference of the Applied Mechanics Division paper (in type; to be published in **Trans. ASME—J. Appl. Mech.**; available to April 1, 1961).

Often, in studies of the dynamic response of structures to transient loads, one wishes to measure the response of quite large structures to loading resulting from rapid release of energy from large energy sources. The very size of the structure and the magnitude of the energy release can preclude laboratory testing, or render full-scale testing prohibitively expensive and time-consuming. One must then resort to other techniques for obtaining the structural response.

As in many other branches of science, tests of suitably scaled models can be substituted for the full-scale experiments, and the response of the full-scale structures inferred from a knowledge of the model laws.

Model laws are here reviewed for blast loading from explosive charges and for the small-deflection elastic response of structures to such loading.

Laws are also discussed for large-deflection elastic response and for plastic response, and the results of experiments conducted to confirm the modeling are presented.

On the Theoretical Analysis of a Dynamic Thermocouple: 2—The Continuous Area Interface..60—APM-19... By W. F. Hughes and E. W. Gaylord, Assoc. Mems. ASME, Carnegie Institute of Technology, Pittsburgh, Pa. 1960 ASME Summer Conference of the Applied Mechanics Division paper (in type; to be published in **Trans. ASME—J. Appl. Mech**; available to April 1, 1961).

The dynamic thermocouple formed by the moving junctions of two dissimilar metals is analyzed for the case of two semi-infinite bodies of dissimilar metals having continuous contact and nonuniform temperature distribution over a circular area.

A procedure is given for determining the potential measured by the thermocouple leads placed in the two respective bodies at an infinite distance away from the contact area in terms of the Seebeck emf corresponding to the contact-area temperature distribution. This thermocouple potential at infinity is solved completely for a circular contact area, and numerical examples are given for the case of radial symmetry.

It is found that the potential at infinity is not in general equal to the area average Seebeck emf. Instead, it is shown that the potential at infinity is equal to the average Seebeck emf weighted by the area divided by its distance from the perimeter of the circle.

This result together with comparison with the results of a previous paper leads to the conclusion that the temperature near the perimeter of a contact area has a greater influence on the thermocouple emf than the temperature in the interior of the contact area.

On Strain-Hardened Circular Cylindrical Shells..60—APM-20... By Nicholas Perrone, Assoc. Mem. ASME, Pratt Institute, Brooklyn, N. Y.; and P. G. Hodge, Jr., Mem. ASME, Illinois Institute of Technology, Chicago, Ill. 1960 ASME Summer Conference of the Applied Mechanics Division paper (in type; to be published in **Trans. ASME—J. Appl. Mech.**; available to April 1, 1961).

The problem of establishing a theory of shells may be approached in one of two ways. On the one hand, certain assumptions can be made regarding the shell material and its contruction and the desired relations between stress and strain resultants deduced therefrom. Alternatively, the resultants can be assumed as generalized variables and their relations postulated directly. The first method has more physical appeal; the second may offer certain simplifications.

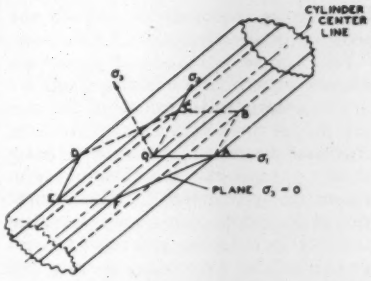
Both methods are demonstrated here, and solutions to various problems obtained and compared. A consistent kinematic hardening theory termed complete hardening, based on a Tresca initial yield condition, is applied to determine the general flow laws for rotationally symmetric shells. The results are then particularized for a circular cylindrical shell without end load. Finally, a corresponding direct theory is presented.

The two theories are then applied to a particular example. Representative "long" and "short" cylindrical shell problems with zero axial load are solved using complete hardening and a simpler but approximate kinematic hardening theory, termed direct hardening.

Finally, in a discussion of the significance of the particular problems considered and of the theory in general, the direct-hardening results are compared (favorably) with the complete hardening ones.

Stresses in Curved Beams of Noncircular Center Line..60—APM-21... By M. M. Abbassi, Alexandria University, Alexandria, Egypt. 1960 ASME Summer Conference of the Applied Mechanics Division paper (in type; to be published in **Trans. ASME—J. Appl. Mech.**; available to April 1, 1961).

The problem of determining the stresses



Perspective of Tresca yield surface. A consistent kinematic hardening theory is applied to determine the general flow laws for rotationally symmetric shells (60—APM-20).

in curved beams of circular center line under the action of couples and forces in their plane of initial curvature has been treated by many authors. Stress in a curved beam of circular center line under the action of forces and couples out of its plane of initial curvature was treated by the author in his first PhD thesis.

But the problem seems to be more complicated if the center line of the curved beam is not circular. An attempt is made here to simplify the problem by using complex variable and curvilinear co-ordinates.

The body-stress equations and the compatibility equations for stresses in their general form are found for the chosen system of co-ordinates and put in their simplest form. Solutions for the equations with the aim of finding the stresses when the beam is subjected to a torque and to a bending out of its plane of initial curvature are obtained for both elliptic and circular cross sections of the beam.

The case of a concentrated load at one end perpendicular to the plane of initial curvature is also considered.

The Elastoplastic Thick-Walled Sphere Subjected to a Radial Temperature Gradient..60—APM-22... By G. R. Cowper, National Aeronautical Establishment, National Research Council, Ottawa, Canada. 1960 ASME Summer Conference of the Applied Mechanics Division paper (in type; to be published in **Trans. ASME—J. Appl. Mech.**; available to April 1, 1961).

An exact solution is obtained for the behavior of an ideal elastoplastic hollow sphere that is thermally stressed by a slowly increasing temperature difference between the inner and outer surfaces.

The surfaces of the sphere are free of traction, and it is assumed that the sphere is initially free of residual stress. The material of the sphere is ideally plastic, homogeneous, and isotropic, with a yield limit that is independent of hydrostatic pressure and temperature. Infinitesimal strains are assumed, and it may be confirmed *a posteriori* that this assumption is justified for an extremely wide range of temperatures.

An approximate analysis in which elastic strains are neglected is also presented. It is shown that the approximate analysis gives the asymptotic form of the exact solution at infinitely high temperatures.

Shock Spectra of a Nonlinear System..60—APM-23... By W. T. Thomson, Mem. ASME, University of California, Los Angeles, Calif. 1960 ASME Summer Conference of the Applied Mechanics Division paper (in type; to be published in **Trans. ASME—J. Appl. Mech.**; available to April 1, 1961).

A shock spectrum is a plot of the maximum peak response of a linear single-degree-of-freedom oscillatory system to a specified shock excitation, as a function of the natural frequency of the oscillatory system. If the spring of the oscillatory system is nonlinear, the peak response will differ, and, although it could be plotted as a function of the natural frequency based on the initial stiffness, another factor describing the nonlinear character of the spring must be introduced.

The peak response under pulse excitation, of a single-degree-of-freedom system with nonlinear spring, which is here approximated by two straight lines, is analytically determined.

Idealization by two straight lines enables its nonlinear description to be specified by a simple parameter. Shock spectra for the step and delta function are developed with damping as parameter. For the rectangular pulse excitation, the shock spectra for zero damping are presented with pulse duration as a parameter.

For the arbitrary pulse shape, a general procedure is discussed and illustrated for the sine pulse of differing pulse duration. Generalized phase-plane plots associated with the problem are included.

The shock spectra presented are applicable only when the first peak corresponds to the maximum response, thereby avoiding the questions of unloading.

Transient Conduction in Coaxial Cylinders With Relative Motion and Heat Generation..60—APM-24... By V. S. Arpaci, Istanbul Technical University, Istanbul, Turkey. 1960 ASME Summer Conference of the Applied Mechanics Division paper (in type; to be published in **Trans. ASME—J. Appl. Mech.**; available to April 1, 1961).

Transient temperatures in a coaxially moving tube and a stationary rod resulting from a step change in the rate of energy generation within the rod are obtained.

For the small values of time, the use of finite Hankel transforms reduces the

problem to the solution of an integrodifferential equation. In the solution of this equation, Laplace transforms have been used considering the convolutive property of the kernel involved.

For the large values of time, this method is not convenient, and the asymptotic behavior of the temperature functions is given by means of the classical approach which requires the use of Laplace transforms. For a given time, it is found that the interface temperature gradient is inversely proportional to the axial distance.

A Method for Investigating Certain Eigenvalue Problems of the Buckling and Vibration of Plates..60—APM-25... By H. D. Conway, Cornell University, Ithaca, N. Y.; and A. W. Leissa, Assoc. Mem. ASME, Ohio State University, Columbus, Ohio. 1960 ASME Summer Conference of the Applied Mechanics Division paper (in type; to be published in **Trans. ASME—J. Appl. Mech.**; available to April 1, 1961).

When solving boundary-value problems, a series solution to the differential equation may be written, but it is frequently impossible to meet the required conditions at all points on the boundary.

To overcome this difficulty, the boundary conditions may be met only at discrete points, retaining sufficient terms in the series solution to meet the conditions at these points. The greater the number of points chosen, the greater in general will be the accuracy of the results.

This method lends itself well to the use of the electronic digital computer, and has been successful in the approximate solution of a number of boundary-value problems.

It is extended here to investigate the eigenvalue problems of the buckling under two-dimensional hydrostatic loading and the vibration of thin plates. The two-dimensional hydrostatic buckling loads of clamped square and equilateral-triangular plates are found by this method, the values agreeing well with the results obtainable by other methods where these results are known.

Elastic Instability of Rectangular Sandwich Panel of Orthotropic Core With Different Face Thicknesses and Materials..60—APM-26... By C. C. Chang and I. K. Ebcioglu, Institute of Technology, University of Minnesota, Minneapolis, Minn. 1960 ASME Summer Conference of the Applied Mechanics Division paper (in type; to be published in **Trans. ASME—J. Appl. Mech.**; available to April 1, 1961).

A great deal of theoretical effort has recently been devoted to buckling and bending of a homogeneous isotropic-cored sandwich panel with identical faces.

However, the simplifying assumptions made in some of the early theories were found to be inadequate to explain the behavior of aircraft sandwich structures.

For example, in a sandwich panel with a honeycomb core the modulus of rigidity in the longitudinal direction of the core may be 2.5 times as much as that in the crosswise direction. Also, the ultimate shear stresses in the two directions mentioned are quite different. The assumption of the isotopic core cannot be applied without introducing appreciable error, particularly for a core weak in transverse shear.

As an added complication, the two faces may be of different thicknesses and materials in many applications. Furthermore, the exposed outer face of the sandwich panel may be subjected to a much higher temperature than the inner face, weakening the material and reducing its modulus of elasticity.

Therefore a revision of existing theories seems necessary to take into account the practical features of sandwich structures in high-speed aircraft.

In treating the instability of rectangular sandwich panels with nonisotropic cores and faces of different materials or thicknesses, a simply supported panel is loaded with a uniform edge compression.

The solution is expressed in terms of a major buckling coefficient, given as the ratio of the critical lateral buckling load to the critical cylindrical buckling load, which is a function of several nondimensional parameters.

A single family of curves shows the buckling behavior for all parameters. The effect of a moderate temperature differential between the two faces can be approximately considered by modifying their moduli of elasticity in accordance with their temperature levels.

Besides the regular panel instability, a zone of core shear instability is determined and discussed in detail. Numerical examples are presented to illustrate the application of the analysis.

Two-Dimensional Gas Jets..60—APM-27... By M. J. Cohen, Northampton College of Advanced Technology, London, England. 1960 ASME Summer Conference of the Applied Mechanics Division paper (in type; to be published in **Trans. ASME—J. Appl. Mech.**; available to April 1, 1961).

A method is described for solving certain problems of subsonic aerodynamic design where flow boundaries in the physical plane are required to have specific dynamic characteristics. The method is tested on two type-problems with known exact solutions; the two-dimensional gas jet and the flow in the neighborhood of stagnation points.

The two-dimensional gas-jet problem has been selected as a vehicle for solving two-dimensional subsonic fluid-flow problems of the indirect variety, which involve the design of aerodynamic objects to perform specified practical functions.

Therefore, theoretically, the problem is set and solved in the hodograph plane which involves the dynamic parameters of the flow; the resultant physical boundary which will achieve the specific boundary conditions in the hodograph plane, is derived by means of the standard transformation linking hodograph and physical planes.

The gas-jet problem and solution representing a classical advance in the field of high subsonic aerodynamics was chosen to ease an apprehension of the present method and also on account of the vast amount of research carried out on that particular topic.

The method has also been used by the author for the design of wind-tunnel contractions (noncirculatory flow) and for the design of cascade blading (circulatory flow). It is applicable whenever the equivalent incompressible-flow problem of the indirect variety, involving constant-inclination and constant-velocity boundaries in the hodograph plane, is soluble by standard conformal techniques except where there are singularities on the hodograph boundaries; even then the errors involved are of such an order as to be often acceptable for practical purposes.

Thermoelastic Stresses in Beams..60—APM-28... By E. S. Barrekette, Columbia University, New York, N. Y. 1960 ASME Summer Conference of the Applied Mechanics Division paper (in type; to be published in **Trans. ASME—J. Appl. Mech.**; available to April 1, 1961).

The behavior of elastic, free beams of arbitrary constant cross section under an arbitrary temperature distribution is investigated.

An analytical method of successive approximations for the solution of linear partial differential equations is applied to the solution for thermoelastic stresses in such beams. The stresses are obtained in terms of series, the nth terms of which are of the form $\beta^n \mathfrak{L}_n(\partial^n T/\partial^n x)$ where β is the ratio of the maximum linear dimension of the cross section to the length of the beam, T is the temperature, x is the ratio of the axial co-ordinate to the length of the beam, and $\mathfrak{L}_n$ is a homogeneous linear integral differential operator in y and z only.

When Poisson's ratio is zero, the first term of the series for the normal axial stress is identical with the solution based on a strength-of-materials analysis, and the first term of the series for the axial displacement leaves plane sections plane. The leading terms of the series

provide good approximations when the temperature can be expanded in a rapidly convergent power series and in long bars ($\beta \ll 1$).

The case of beams of constant circular cross section under temperatures varying only with the axial co-ordinate is examined and a numerical example is presented.

Dynamical Response of an Elastic Half-Space to Tangential Surface Loadings..60—APM-29... By Chi-Chang Chao, Stanford University, Stanford, Calif. 1960 ASME Summer Conference of the Applied Mechanics Division paper (in type; to be published in **Trans. ASME—J. Appl. Mech.**; available to April 1, 1961).

The dynamic response of an elastic half space under the action of a time-dependent concentrated force has attracted the interest of many applied scientists. Owing to the complexities of the mathematics involved, all of the literature concerning this kind of problem has been confined to axial symmetrical or two-dimensional cases, where the concentrated force is acting perpendicular to its plane boundary (or a line source acts on it).

The response of an elastic half space to tangential surface loadings to be considered here cannot make use of the simplifications that accompany axial symmetry. Surface displacements and displacements directly below the applied force, which varies with time as the Heaviside unit function, are obtained in closed form with the aid of integral transform techniques and a semi-inverse method.

The reciprocal relation in the static case, between tangential displacement due to a vertical force and vertical displacement due to a tangential force is preserved in the dynamic case.

Thermal Transfer in Turbulent Gas Streams. Effect of Turbulence on Local Transport From Spheres..60—APM-30... By W. W. Short, Convair, San Diego, Calif.; R. A. S. Brown, University of Alberta, Edmonton, Canada; and B. H. Sage, California Institute of Technology, Pasadena, Calif. 1960 ASME Summer Conference of the Applied Mechanics Division paper (in type; to be published in **Trans. ASME—J. Appl. Mech.**; available to April 1, 1961).

Many experimental measurements have been made of the gross convective thermal transport from spheres in a free stream, and these have been well correlated for conditions of turbulent flow. But studies of local thermal transport from such spheres are limited.

A series of measurements was made of the local thermal transport in the forward hemisphere and a part of the after hemisphere of a silver sphere 0.5 in. diam. The measurements were made in an undisturbed air stream and at several positions in the wake of a grid inserted in the air stream.

The apparent level of longitudinal turbulence was varied between 0.013 and 0.15 for Reynolds numbers up to 3600. At an apparent level of turbulence of 0.013 and a Reynolds number of 3600, the local thermal transfer varied by a factor of eight around the sphere. Increasing the apparent level of turbulence to 0.15 increased the over-all thermal transfer 20 per cent. The local thermal transfer varied by a factor of five at the latter level of turbulence.

Plastic Analysis of Circular Conical Shells..60—APM-31... By P. G. Hodge, Jr., Mem. ASME, Illinois Institute of Technology, Chicago, Ill. 1960 ASME Summer Conference of the Applied Mechanics Division paper (in type; to be published in **Trans. ASME—J. Appl. Mech.**; available to April 1, 1961).

It has previously been shown that the collapse load of a rigid perfectly plastic plate subjected to a concentrated load Q is given by $Q = 2\pi M_0$ independently of the size or shape of the plate or the manner in which it is supported at the edge. In the present paper, a similar result will be obtained for a conical shell, loaded at its vertex.

A right circular conical shell of edge angle α is subjected to a concentrated load Q directed along the axis. The collapse load is found to be $Q = 2\pi M_0 \cos^2\alpha$, independently of the size or support conditions of the shell.

It is difficult to make a direct formal analysis of a plate or shell subjected to a concentrated load since the resulting shear force at the point of load application is infinite.

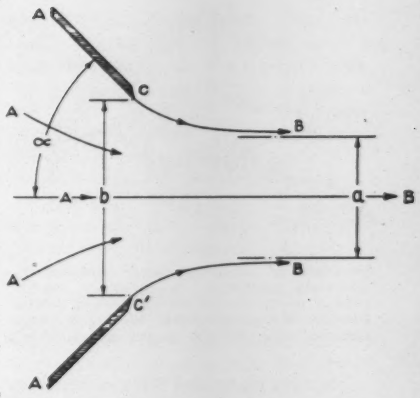
Therefore, after reviewing the necessary "Basic Equations," a shell is considered on which the load is applied over a small but finite area.

A complete solution is obtained for fairly flat shells and an upper bound is found for all shells. Complete solutions for shells of medium flatness are given in an appendix.

Also indicated is the approach to the problem of a general shell of revolution subjected to a concentrated load at its vertex. The collapse load is shown to be between that of a flat plate and a circumscribed conical shell.

Random Excitation of a Loaded Nonlinear String..60—APMW-1... By T. K. Caughey, California Institute of Technology, Pasadena, Calif. 1960 West Coast Conference of the ASME Applied Mechanics Division paper (in type; to be published in **Trans. ASME—J. Appl. Mech.**; available to April 1, 1961).

The linearized problem of the oscillations of a light string loaded at equal intervals was first discussed by Bernoulli and later in more detail by Lagrange. In their treatment, the tension in the string was assumed to remain constant; however, even for small deflections the tension in the string increases, giving rise to nonlinear effects. These nonlinear effects have been studied by several authors in the case of the continuous mass distribution.



Two-dimensional gas jet in physical plane; $r = a/b$ (60—APM-27)

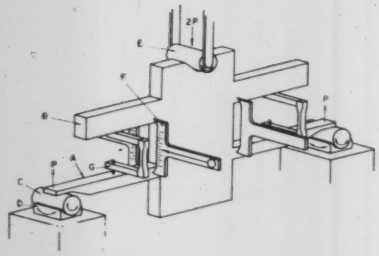
These effects are analyzed here in the case of massless elastic string connecting a chain of particles and subject to a random excitation.

It is shown that, as a result of the additional stress induced by the stretching of the string, the mean squared deflection of every particle is reduced compared with that for the equivalent linear problem.

Expansion of Thick-Walled Cylinders Fabricated From Cold Bent Plates..60—APMW-2... By Irwin Berman, Mem. ASME, Foster Wheeler Corporation, New York, N. Y. 1960 West Coast Conference of the ASME Applied Mechanics Division paper (in type; to be published in **Trans. ASME—J. Appl. Mech.**; available to April 1, 1961).

The problem of the stresses and deformations in inhomogeneous and anisotropic thick-walled cylinders that were made of a strain-hardening material is considered.

The thick-walled cylinders were fabricated from plates which had been cold bent into the cylindrical shape. It is assumed that before they were bent the flat plates had homogeneous but anisotropic strength properties. Since a strain-hardening material is being considered, the strength properties of the plates after they are bent into the cylindrical shape may be both inhomogeneous and anisotropic.



Experimental setup. **A**—test cantilever, **B**—reference cantilever, **C**—roller of loading bolster, **D**—cylindrical seat of loading bolster, **E**—roller of support bolster, **F**—Huggenberger extensometer, **G**—clip gages (60—APMW-3)

The bent plates and cylinder heads are assumed to be assembled so that the initial material properties of the cylindrical portion of the pressure vessel are the same as the final material properties of the bent plate. Therefore the cylinder analysis will include the effect of fabrication as an integral part of the results.

A short review of those portions of the theory used here, piecewise linear plasticity based on principal-shear stresses, is presented. The strength properties of the plates after they are bent into the cylindrical shape are determined, and the cylinder analysis given.

Expressions are developed from which the stresses and strains in the cylinder may be determined in terms of various material constants. Finally, a numerical example illustrates the importance of the results in terms of the difference in cylinder behavior for materials with similar initial yield and strain-hardening properties but different secondary hardening properties.

The Additional Deflection of a Cantilever Due to the Elasticity of the Support..60—APMW-3...By W. J. O'Donnell, Assoc. Mem. ASME, Westinghouse Bettis Atomic Power Laboratory, Pittsburgh, Pa. 1960 West Coast Conference of the ASME Applied Mechanics Division paper (in type; to be published in **Trans. ASME—J. Appl. Mech.**; available to April 1, 1961).

Whether or not a cantilever is machined integral with the support, there will be elastic distortions in the support which allow the cantilever to rotate at the built-in end. This rotation produces a deflection in addition to that caused by bending and shear stresses in the beam itself.

Such imperfect clamping deflections become significant relative to the greatly reduced bending deflections at small length-to-depth ratios. An experimentally verified expression is presented for the additional deflection of a cantilever due to the elasticity of a semi-infinite support fixed at infinity.

A beam is cantilevered from a semi-infinite solid with neutral axis normal to its bounding plane (two-dimensional problem). Deformation of the supporting solid allows the beam to rotate about the built-in end, producing a deflection in addition to that caused by bending and shear in the beam itself.

Results of tests designed to measure this additional deflection are presented and compared with various theoretical values. Calculated deflections, based on classical bending and shear-deflection theory, are also compared with measured deflections. An experimentally verified expression for the additional deflection of a cantilever due to the elasticity of the support is given.

Stress Distributions Analyzed in Bispherical Co-Ordinates..60—APMW-4...By T. P. Mitchell, Cornell University, Ithaca, N. Y.; and J. A. Weese, USAF Academy, Colo. 1960 West Coast Conference of the ASME Applied Mechanics Division paper (in type; to be published in **Trans. ASME—J. Appl. Mech.**; available to April 1, 1961).

Boussinesq-Papkovich potentials are used in conjunction with the bispherical co-ordinate system to analyze three problems in the classical theory of linear elasticity: (*a*) The extension of the Boussinesq point-load problem to that in which the half space contains a spherical cavity; (*b*) the determination of the stress distribution in an eccentric spherical shell under uniform internal pressure; (*c*) the determination of the stress distribution in a half space containing a uniformly pressurized spherical cavity. Numerical results are presented for representative configurations and load distributions in each case.

Effect of Small Hub-Radius Change on Bending Frequencies of a Rotating Beam..60—APMW-5...By Hsu Lo, J. E. Goldberg, and J. L. Bogdanoff, Mem. ASME, Purdue University, Lafayette, Ind. 1960 West Coast Conference of the ASME Applied Mechanics Division paper (in type; to be published in **Trans. ASME—J. Appl. Mech.**; available to April 1, 1961).

By the method of perturbation, a simple relation is formulated for the determination of the change of bending frequencies of a rotating beam due to a small change of hub radius.

The first-order solution shows that a frequency parameter γ is a linear function of the hub-radius change and the constant of proportionality is readily obtainable from known parameters. The frequency ω itself can also be represented by a linear function of the hub-radius change. This confirms the results previously obtained by Boyce by repeated solutions of the differential equations for a particular beam.

Higher-order solutions are also established and shown to be convergent within the limitation imposed on the amount of the hub-radius change allowable.

Thermal Stresses Due to Disturbance of Uniform Heat Flow by an Insulated Ovaloid Hole..60—APMW-6...By A. L. Florence and J. N. Goodier, Mem. ASME, Stanford University, Stanford, Calif. 1960 West Coast Conference of the ASME Applied Mechanics Division paper (in type; to be published in **Trans. ASME—J. Appl. Mech.**; available to April 1, 1961).

When an infinite plate is under a temperature distribution which is uniform but for the disturbance caused by the presence of an insulated ovaloid hole, thermal stresses are produced.

The linear thermoelastic problem is solved for a uniform heat flow disturbed by a hole of ovaloid form, which includes the ellipse and circle as special cases. Results for stress and displacement are found in closed form, by reducing the problem to one of boundary loading solvable by a method of Muskhelishvili.

On a Class of Nonlinear Axisymmetric Plate Problems..60—APMW-7...By F. Eessenburg, Assoc. Mem. ASME, Illinois Institute of Technology, Chicago, Ill. 1960 West Coast Conference of the ASME Applied Mechanics Division paper (in type; to be published in **Trans. ASME—J. Appl. Mech.**; available to April 1, 1961).

Physical inconsistencies are to be found in some classical conclusions of problems involving uniform axisymmetric circular plates, portions of which are constrained from deflection by the presence of a smooth, rigid, plane surface parallel to the undeformed middle plane of the plate. The validity of the classical treatment of such problems is re-examined.

Both the practical and conceptual advantages of carrying the analysis within the scope of the E. Reissner plate theory are illustrated by means of an example, a simply supported circular plate subjected to a uniform load at its top surface and constrained from deflection by a smooth, rigid, plane surface situated a distance below the undeformed bottom surface.

Thermal Stresses in an Elastic, Work-Hardening Sphere..60—APMW-8...By Chintsun Hwang, Mem. ASME, National Cash Register Company, Hawthorne, Calif. 1960 West Coast Conference of the ASME Applied Mechanics Division paper (in type; to be published in **Trans. ASME—J. Appl. Mech.**; available to April 1, 1961).

A method is presented for obtaining transient and residual stresses in a hollow or solid spherical body. The mechanical and thermal properties are assumed to be temperature independent. The temperature distribution, which is symmetrical with respect to the center of the sphere, is determined by the classical solution based on specific boundary conditions.

The material of the spherical body is elastic, work-hardening. The von Mises' yield condition is used. In the work-hardening range, the material hardens isotropically. In both the elastic and the work-hardening ranges, appropriate flow rules are used.

The problem is reduced to a single nonlinear differential equation, which determines the changes in stress deviation in the spherical body as a result of specific temperature changes. The stress distribution, either transient or residual, is then obtained by further integration.

The differential equation is solved numerically on the NCR 304 digital computer. A flow diagram, indicating the computation procedures, is given in the paper. Numerical data are presented which give the thermal stresses in an elastic, work-hardening sphere with uniform initial temperature and cooling in an infinite medium of lower temperature according to Newton's law. Three distinct cases of thermal-stress distribution in the sphere are given, each case representing a different degree of work-hardening in the sphere during the cooling process.

On the Response of an Elastic Half-Space to a Moving Blast Wave..60—APMW-9... By J. W. Miles, University of California, Los Angeles, Calif. 1960 West Coast Conference of the ASME Applied Mechanics Division paper (in type; to be published in **Trans. ASME—J. Appl. Mech.**; available to April 1, 1961).

The response of a solid medium to a blast wave moving over its surface is a problem of considerable importance in the design of blast-resistant structures. Perhaps the simplest model for this problem that still retains the essential features of wave propagation in a solid is provided by a two-dimensional load distribution, say $p(x - Ut)$, moving with uniform velocity U over the free surface of an elastic half-space.

This problem has been solved several times, but it has some deficiences, which are listed here.

The author then considers the response of an elastic half-space to a radially symmetric pressure signature for which both peak pressure and blast-wave speed decay with distance from the epicenter. This model is without the difficulties of the former one.

Procedure consists, first, in obtaining a formal solution to the boundary-value problem through integral transforms. The Bessel functions in this formal solution are then replaced by the first terms in their asymptotic approximations, expressed in terms of the known solution for the response of a half space to a two-dimensional pulse moving with constant velocity, plus a correction that is important only if the blast-wave speed directly above the point of observation is close to the Rayleigh-wave speed.

The Elastic Half Plane Subjected to Surface Tractions With Random Magnitude or Separation..60—APMW-10... By A. C. Eringen and J. W. Dunkin, Purdue University, Lafayette, Ind. 1960 West Coast Conference of the ASME Applied Mechanics Division paper (in type; to be published in **Trans. ASME—J. Appl. Mech.**; available to April 1, 1961).

The elastostatic problem of a half plane acted upon by boundary tractions on its straight boundary is classical. However, when the surface tractions are randomly distributed, a novel problem arises which has not been treated to date.

Quite often, in many problems encountered in engineering, either the magnitude or the location of the surface tractions is not known precisely as, for example, when a random noise is applied to the surface. We may, however, have some knowledge of the mean and mean-square values of these loads or their locations, whichever is random. It may happen that certain mean-square errors are made in locating the loads; it would then be of interest to find what the mean-square error would be in the stresses. In such cases, the methods of deterministic analysis are not applicable, and so a method such as the one presented in this paper is needed for answers to these problems. The method used here is suggestive in that it applies to other types of problems in elasticity theory.

The problem, in essence, is to find the mean and mean-square values and cross correlations of stress components given either the same information for the surface tractions or else their probability density functions.

First and second-order moments of the stress tensor are obtained for the elastostatic problem concerning the half plane subjected to random boundary tractions. The cases treated include the following types of applied surface tractions: (*a*) A purely random Gaussian load (white noise); (*b*) concentrated loads of random magnitudes separated by equal intervals; (*c*) a concentrated load acting at a random location; and (*d*) concentrated loads of equal magnitudes separated by random intervals.

Flexural Stress Waves in an Infinite Elastic Plate Due to a Suddenly Applied Concentrated Transverse Load..60—APMW-11... By Julius Miklowitz, Mem. ASME, California Institute of Technology, Pasadena, Calif. 1960 West Coast Conference of the ASME Applied Mechanics Division paper (in type; to be published in **Trans. ASME—J. Appl. Mech.**; available to April 1, 1961).

The problem solved is that of an infinite plate subjected to a suddenly applied concentrated transverse shear load. The solution is derived from a plate theory that incorporates, in addition to bending, the effect of shear force and rotary inertia on the deflection. These added effects give the present theory true wave character along with greater accuracy in the waves predicted.

Numerical evaluation of the solution brings out the effects of dispersion and distortion on the moment and shear-force response of the plate. A criterion is developed for judging the accuracy of this response. It is based on a comparison, employing the stationary phase method, of the present approximate and exact (three-dimensional) theories.

Free, Transverse Vibrations of a Solid Elastic Mass in an Infinitely Long, Rigid, Circular-Cylindrical Tank..60—APMW-12... By J. H. Baltrukonis, Space Technology Laboratories, Inc., Los Angeles, Calif. 1960 West Coast Conference of the ASME Applied Mechanics Division paper (in type; to be published in **Trans. ASME—J. Appl. Mech.**; available to April 1, 1961).

The present problem was motivated by an interest in the free transverse vibrations of solid-propellant rocket motors consisting of relatively rigid casings with extremely compliant, solid-propellant cores.

Basically, the problem is that of plane strain vibrations of a solid, elastic cylinder clamped along its cylindrical surface.

A short summary is presented of the general theory of vibrations of elastic, continuous media in polar, cylindrical co-ordinates. Then a transcendental frequency equation is derived relating the natural circular frequency coefficients and Poisson's ratio. An interesting steplike variation is obtained for all branches of this relationship.

Parametric equations defining the displacement fields are derived corresponding to each of the natural frequencies. These displacement fields are plotted for two natural frequencies in each of the first three modes.

The Propagation of an Impulse Into a Viscous-Locking Medium..60—APMW-13... By J. W. Miles, University of California, Los Angeles, Calif. 1960 West Coast Conference of the ASME Applied Mechanics Division paper (in type; to be published in **Trans. ASME—J. Appl. Mech.**; available to April 1, 1961).

A viscous-locking medium is defined by the compressive stress-strain relation $p = f(\epsilon) + \mu\epsilon_t$, where $f(\epsilon) = 0$ for $\epsilon < \epsilon_c$ and $f'(\epsilon_c) = \infty$; it behaves as a viscous liquid until the compressive strain attains the value ϵ_c, after which it behaves as a rigid solid. A general solution is given for the disturbance produced by a pressure

$p_0(t)$ acting on an inviscid ($\mu = 0$) half space, in which case the transition from viscous to rigid phases occurs through a shock wave. It is found that the stress falls off inversely as the square of the depth of penetration and that it may be approximated (asymptotically) by the disturbance produced by a concentrated impulse. A similarity solution then is given for a concentrated impulse acting on a viscous half space. It is concluded that viscosity reduces the peak pressure at all depths, even though the disturbance is diffused into the viscous phase and may achieve its peak value in that phase.

The Bending Stress Distribution at the Base of a Stationary Crack..60—APMW-14... By M. L. Williams, California Institute of Technology, Pasadena, Calif. 1960 West Coast Conference of the ASME Applied Mechanics Division paper (in type; to be published in **Trans. ASME—J. Appl. Mech.;** available to April 1, 1961).

Extending an earlier paper dealing with extensional stress distributions, M. L. Williams, "On the Stress Distribution at the Base of a Stationary Crack," this study considers the stresses around a crack point owing to bending loads.

It is found first that the stresses possess the characteristic inverse square-root singularity in terms of distance from the crack point. Along the crack prolongation direction the symmetric principal stresses are of opposite sign and in the ratio $(1 - \nu)/(3 + \nu)$, in contrast to the extensional situation where they are identically equal. This leads to the observation that more yielding might be expected as the percentage of bending to extension stress at the crack increases. In the antisymmetrical loading, the shear stress is a maximum ± 90 deg to the side of the crack, where the distortion energy is also a maximum.

Interesting reciprocity relationships are also shown to exist between the symmetrical and antisymmetrical loading conditions for the isochromatic fringe lines and the stress trajectories. Finally, the results are discussed in connection with the combined extensional and bending loading.

Some Gyroscopic Oscillations..60—APMW-15... By C. J. Thorne, U. S. Naval Ordnance Test Station, China Lake, Calif. 1960 West Coast Conference of the ASME Applied Mechanics Division paper (in type; to be published in **Trans. ASME—J. Appl. Mech.;** available to April 1, 1961).

The use of gyroscopes as direction-preserving devices is becoming standard in various dynamic systems. Owing to necessary application of forces, mechanical coupling, aerodynamic coupling, and practical difficulties of manufacture, the actual situation is a gyro subjected to various forces.

Only an important special case of this more general problem is considered here; a gyro being accelerated (constant force) in a fixed direction and acted on by a torque proportional to the angle between the fixed direction and the axis of the gyro. Curves of results from IBM 704 calculations of the approximation formulas and REAC curves from the differential equations are given.

ASME TRANSACTIONS

The September, 1960, issues of the Transactions of the ASME—*Journal of Basic Engineering* and *Journal of Applied Mechanics* (available at $1.50 per copy to ASME Members; $3 to nonmembers) —contain the following:

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513 Precise Measurement of Clothes Insulation During Controlled Operation of the Human, by A. S. Iberall. (59—A-197)

528 Radial Distributions of Temporal-Mean Peripheral Velocity and Pressure for Fully Developed Turbulent Flow in Curved Channels, by A. W. Marris. (59—A-51)

539 Flow Phenomena of Partially Enclosed Rotating Disks, by L. A. Maroti, G. Deak, and F. Kreith. (59—A-49)

553 Roughness Effects on Frictional Resistance of Enclosed Rotating Disks, by R. E. Nece and J. W. Daily. (59—A-55)

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575 Incidence and Deviation-Angle Correlations for Compressor Cascades, by Seymour Lieblein. (59—A-171)

588 A Study of Boundary-Layer Characteristics of Turbomachine Blade Rows and Their Relation to Over-All Blade Loss, by W. L. Stewart, W. J. Whitney, and R. Y. Wong. (59—A-23)

593 Laminar Boundary Layers in Oscillatory Flow, by P. G. Hill and A. H. Stenning. (59—A-265)

609 Experimental Determination of Statistical Properties of Two-Phase Turbulent Motion, by S. L. Soo, H. K. Ihrig, Jr., and A. F. El Kouh. (59—A-59)

622 The Turbulent Boundary Layer at a Plane of Symmetry in a Three-Dimensional Flow, by J. P. Johnston. (59—A-72)

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496 The Elastoplastic Thick-Walled Sphere Subjected to a Radial Temperature Gradient, G. R. Cowper. (60—APM-22)
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541 Extensional Vibrations and Waves in a Circular Disk and a Semi-Infinite Plate, D. C. Gazis and R. D. Mindlin. (60—APM-3)
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593 Discussion of previously published papers by S. A Hovanessian; V. L. Salerno and M. A. Goldberg; M. A. Goldberg and Michael Sadowsky; Wen-Hsiung Li; T. R. Goodman and J. J. Shea; L. N. Tao

599 BOOK REVIEWS

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COMMENTS ON PAPERS

Reversible Pump-Turbines at Niagara Falls

Comment by Fritz M. Hessemer[1]

THE COMMENTS on this paper[2] are concerned with the design of the pump-turbine runners for weld fabrication. They are based on an article submitted last summer in the James F. Lincoln Arc Welding Foundations Machine Design Award Program.

Some of the problems when Francis runners are bought as one-piece castings are dimensional control, high cost, and extensive repairs. Small Francis runners have been fabricated for many years with plate-steel buckets, and cast crowns and bands.

The first large runner with cast buckets to be weld-fabricated was furnished by Allis-Chalmers in 1946 for the Cheoah Plant of Carolina Aluminum Company. In the early fifties Newport News Shipbuilding & Dry Dock Company cast-weld fabricated ten of the large Chief Joseph runners and, in 1957 and 1958, S. Morgan Smith Company built a total of 14 large Francis turbine runners by this method.

The successful experience on Francis runners indicated that the same techniques could be used on the Tuscarora pump-turbine runners. **Fig. 1** shows one fabricated and one solid cast Tuscarora runner. One significant requirement which is different from Francis turbine runners is that not only the discharge area as a turbine, but also the discharge area as a pump must be held to close tolerances. Foundries were able to work to very close tolerances on shape and thickness for both the vane and stainless-steel insert. **Fig. 2** shows a wood templet set on the mild steel vane and stainless insert for proper alignment. There were 33 check points used on the vane and seven on the insert.

An innovation that assisted greatly in planning details of manufacturing on Tuscarora was a one-ft diam model runner of wood that could be dismantled easily into a crown, six buckets, and a band.

In **Fig. 3** the welder is tacking the insert to the bucket using E-309-16 stainless electrodes. Dye Penetrant inspection was used to insure good quality welds.

An improved technique was casting on the crown about four inches of bucket including the fillet. This provided a definite location reference for the buckets, made deseaming easy, and allowed easy access for x ray of the through welds.

Fig. 4 shows the stub ends, two setup fixtures, and some casting check points. Here the buckets are set up on a pre-machined crown.

A technique to facilitate balancing was to finish-machine the inside of the band before assembly with the buckets and crown. Selective assembly of the buckets was used after recording an initial unbalance in the crown. This reduced the amount of corrective work after final machining.

Some material and welding specifications are: Cast materials: ASTM-A27 (65-35) and type 304 stainless steel. Welding electrodes: Type 7018 and E-309-16.

The band contour was machined on

[1] Quality-Control Manager, Allis-Chalmers Manufacturing Company, York Works, York, Pa. Mem. ASME.

[2] F. E. Jaski and W. W. Weltmer, "Reversible Pump-Turbines at Niagara Falls," MECHANICAL ENGINEERING, vol. 82, March, 1960, pp. 74-77.

Fig. 1

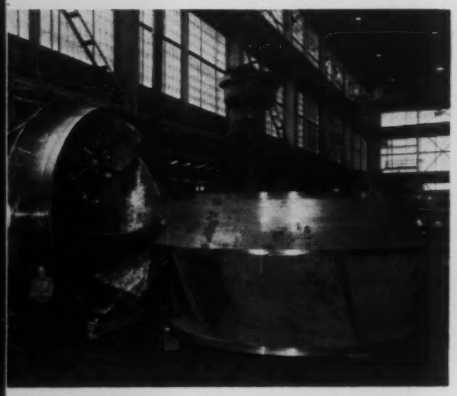

Fig. 2

Fig. 3

Fig. 4

Fig. 6

Fig. 5

Fig. 7 ▶

a 40-ft vertical boring mill, then the band was fitted over the buckets and removed. **Fig. 5** shows the runner on the mill. The band-to-bucket joint was beveled using arc air on the stainless and an oxypropane torch on the mild steel. Two runners are shown in **Fig. 6,** one with band tack welded, the other ready for the mill.

The whole assembly was then mounted on a spindle and finish welded. Preheat was maintained using torches and a piping arrangement as shown in **Fig. 7.** After stress relief the runner was metal blasted and all welds magnafluxed.

It was then considered as though furnished by a foundry with the added bonus of a rough-turned band and crown and a finished faced crown.

The acquisition by Allis-Chalmers of S. Morgan Smith Company and the subsequent decision to overlay and finish-machine the six solid-cast runners in the York Works, allowed a comparison of both methods of manufacture to be made.

In addition to the previously mentioned innovations, three other advantages resulted from the use of weld fabrication. These are:

1 No cast components were rejected so that production scheduling was simple and planned schedules were met. This also was aided by the fact that there was a larger number of convenient sources of supply for these smaller components.

2 A considerable number of labor hours of overhead were absorbed in the turbine builder's shops. This would not have occurred had solid-cast runners been purchased.

3 There was easy access for finishing water-flow passage surfaces before the components were welded together.

Authors' Closure

The authors wish to thank Mr. Hessemer for his interesting contribution to this paper.

This is the first time that fabricated construction has been applied to runners for pump-turbines. Due to the difference in the buckets of these runners and buckets of conventional Francis turbine runners, there were problems of construction that had to be met and solved. The photographs truly show the fine quality of the runner obtained with this type of construction.

F. E. Jaski.[3]
W. W. Weltmer.[4]

[3] Engineer in charge, Pump Turbines, Allis-Chalmers Manufacturing Company, Milwaukee, Wis. Mem. ASME.

[4] Engineer in charge, Research and Development, Allis-Chalmers Manufacturing Company, Milwaukee, Wis. Mem. ASME.

Similarity and Dimensional Methods in Mechanics

By L. I. Sedov. 1959, Academic Press, Inc., New York, N. Y. 363 p., $6^1/_4 \times 9^1/_4$ in., bound. $14. Three chapters describe the basic ideas of problem solution methods utilizing physical similarity and dimensional properties, illustrated by applications in mechanics, particularly fluid mechanics. The other two chapters show the power of these methods in solving new problems in the theory of explosions and in astrophysics. Translation from the Russian.

Small Gas Turbines

By Arthus W. Judge. 1960, The Macmillan Company, New York, N. Y. 328 p., $5^1/_2 \times 8^3/_4$ in., bound. $10. This book covers gas turbines ranging from 30 bhp up to about 1500 bhp, emphasizing the medium output engines, and concentrating on their adaptation for other than aircraft propulsion purposes. Included are examples of applications for portable and stationary power purposes, for light aircraft and aircraft piston-engine take-off boosters, for guided missiles, and for automobiles, small marine engines, and turbines operated by high-pressure boiler exhaust gases.

Vacuum Processing in Metalworking

By J. Wesley Cable. 1960, Reinhold Publishing Corporation, New York, N. Y. 202 p., $5^1/_4 \times 7^1/_2$ in., bound. $5.50. A description rather than a rigidly technical presentation, of which the first three chapters cover historical background and production of vacuum, and heating systems for vacuum processes. The remainder of the book describes vacuum techniques for refining, purification, melting, casting, plating, brazing, welding and heat-treatment of metals, and for sintering in powder metallurgy.

Yearbook of the Heating and Ventilating Industry 1959/60

Published 1960 by the Technitrade Journals, Ltd., London, England. Various pagings. $5^1/_2 \times 8^1/_2$ in., bound. £0.15.0. This yearbook contains the annual report of the (British) Association of Heating, Ventilating, and Domestic Engineering Employers, and such results of their activities as hourly rates on jobbing work, apprenticeship agreements, contract forms with various bodies, and by-laws. In addition, there are three papers on design problems relevant to this field, a review of the literature, a buyer's guide, and lists of selected British standards, trade names, manufacturers' addresses, associations, and consulting engineers.

Die Zerspannung der Eisenwerkstoffe

By G. Vieregge. 1959, Verlag Stahleisen, Dusseldorf, Germany. 346 p., 6 × 9 in., 280 illus., 59 tables, 40 DM. The book deals with the science of machining ferrous metals, including tool angles, cutting speeds and feeds, chip formation, temperature of tools, forces acting on tools, wear of tools, and the influence of the interrelations of these factors on the best combinations. It also brings up to date data on the machinability of ferrous materials and on the various tool materials that are available. The book is complete. It is based not only on the author's personal experience, but also on 160 references to prior art and science. With an illustration or a table on every page, a cursory reading requires about 30 hours. A detailed study requires weeks. This book is an excellent reference for tool engineers, industrial engineers, and master-mechanics, provided they can read German and are familiar with metric dimensions.—*W. Trinks*, Fellow ASME.

BOOKS RECEIVED IN LIBRARY

ASTM Standards on Rubber Products

Published 1960 by the American Society For Testing Materials, Philadelphia, Pa. 1024 p., $6^1/_4 \times 9^1/_4$ in., bound. $9.75. Selected topics include the following: chemical and physical tests of vulcanized rubber; electrical, aging, weathering, and low-temperature tests of rubber; automotive and aeronautical rubber; gasket, belting, and tape materials; electrical protective and insulating materials; hard and foam rubbers and synthetic elastomers. Of the 163 items, 22 are new and 66 revised.

Advances in Applied Mechanics, Vol. 6

Edited by H. L. Dryden and others. 1960, Academic Press, Inc., New York, N. Y. 294 p., 6 × $9^1/_4$ in., bound. $9. This sixth volume in the series contains five papers in the field of fluid mechanics. The major article is an extensive survey of similarity methods in aerodynamics. The other papers deal with unsteady boundary layers, shock waves in ducts of varying cross section, recent experimental work on vortex streets, and the flow of a gas in a boundary layer under extreme conditions which give rise to dissociation of the gas.

Advances in the Astronautical Sciences, Vol. 5

(Proceedings of the Second Western National Meeting of the American Astronautical Society, Los Angeles Calif., 1959.) 1960, Plenum Press, Inc., New York N. Y., 356 p., $6^3/_4 \times 10^1/_4$ in., bound. $8. This fifth volume in the series contains papers in six major fields of recent aeronautical research—human factors; space mechanics, control, and guidance; advanced propulsion and power; astronautical systems and space-vehicle design; space communication and instrumentation; lunar and planetary environment.

Direct Conversion of Heat to Electricity

Edited by Joseph Kaye and John A. Welsh, 1960, John Wiley & Sons, Inc., New York. N. Y. Various pagings, bound. $8.75. An edited collection of papers originally presented at the M.I.T. 1959 "Direct Conversion" program which discuss thermionic engines, both high vacuum and low pressure, magnetohydrodynamic conversion, semiconductor devices in thermoelectrics, and fuel cells as energy converters.

The Dymaxion World of Buckminster Fuller

By Robert W. Marks. 1960, Reinhold Publishing Corporation, New York, N. Y. 232 p. $10^1/_2 \times 8^3/_4$ in., bound. $12. This book reflects the author's impressions and interpretations of the life and work of Richard Buckminster Fuller, whose "Dymaxion" idea—getting from any type of structure the maximum net performance per unit of energy input—has created over the past 30 years a steady stream of starting cars, houses, maps, domes, and systems of mathematics. Admittedly biased by personal warmth, the author's account is vastly interesting, and nearly 200 pages of superb glossy annotated photographs further illustrate the man and his work.

Engineering Data Processing System Design

By Arthur D. Even. 1960, D. Van Nostrand Company, Inc., Princeton, N. J. 282 p., $6^1/_4 \times 9^1/_4$ in., bound. $6.50. Discusses mechanization possibilities in the handling of drawings, engineering parts lists, and allied engineering office records as a first step toward electronic data processing systems in the engineering department. Covers the designing, justifying, installing, operating, and controlling of a system which includes the use of microfilm and punched cards, and explores the eventual use of electronic equipment.

Engineering Thermodynamics

By James B. Jones and George A. Hawkins. 1960, John Wiley & Sons, Inc., New York, N. Y. 724 p., 6 × $9^1/_4$ in., bound. $8.50. This undergraduate text concentrates on fundamental concepts, the first and second laws, and physical property relationships. It does not attempt to cover all engineering applications of thermodynamics, but illustrates applications of the basic principles presented in the first fourteen chapters in six chapters on fluid flow, fluid machines, gas and vapor power cycles, refrigeration, and binary mixtures. The elements of heat transfer are briefly discussed in the final chapters. Dimensions and units, and a variety of thermodynamic charts and graphs are given in appendixes.

High-Speed Aerodynamics and Jet Propulsion, Vol. 5: Turbulent Flows and Heat Transfer

Edited by C. C. Lin. 1959, Princeton University Press, Princeton, N. J. 549 p., $6^1/_4 \times 9^1/_2$ in., bound. $15. The principal approaches to the present understanding of turbulent flows are presented here with consideration of both skin friction and heat transfer. Transition from laminar to turbulent flow is treated in a comprehensive section. Following is a discussion of turbulent flow which includes equations for the turbulent motion of a compressible fluid, boundary-layer flows, free turbulent flows, and the structure of shear flows. Statistical, mathematical, and physical aspects of homogeneous turbulence, turbulent diffusion and transfer, and magnetohydrodynamic turbulence are next discussed. The remainder of the volume is devoted to heat transfer by conduction, convection, and radiation.

The Instrument Manual

Third Edition. Published 1960 by United Trade Press, Ltd., London, England. 742 p., $8^3/_4 \times 11$ in., bound. $5.50. Contains descriptions of the purpose, principles, design, and materials of individual instruments used in all areas of measurement and control. The main additions to this third edition are in the fields of nucleonics and viscosity, and in a new section on analog computers; the earlier chapter on navigational instruments has been omitted. Among the areas of measurement and control by instrumentation discussed are weight, conductivity, hydrogen ion concentration, fluid flow, specific gravity or density of liquids, viscosity, pressure and vacuum, temperature, and moisture content of air and gases. Also described are electrical and electronic measuring instruments, aeronautical, surveying, analytical, meteorological counting, and timing instruments, as well as microscopes, telemetering systems, and various highly specialized type.

The Internal Combustion Engine in Theory and Practice, Vol. 1

By Charles Fayette Taylor. 1960, John

Wiley & Sons, Inc., New York, N. Y. 574 p., 6 × 9¼ in., bound. $16. Volume one of this two-volume work is devoted to establishing a rational quantitative basis for design and development and for analysis of performance. Design information in the form of curves, charts, and tables is included for solution of practical design problems. Also covered in detail is engine friction, the relation of actual engine to ideal fuel-air cycles, air-capacity and fluid-flow characteristics of four and two-stroke engines, and the influence of cylinder size on engine characteristics.

Ionization Phenomena in Gases

By Gordon Francis. 1960, Academic Press, Inc., New York, N. Y. 300 p., 5¾ × 8¾ in., bound. $10.50. This graduate-level text complements others by concentrating on those discharges not previously treated collectively. The first two chapters provide a general background in describing the nucleus, ionization, and excitation of the atom, spectra, conduction of electricity in a gas, and the fundamental processes of ionization and deionization. The remaining chapters discuss the similarity principle as applied to discharges, alternating, high-current and high-frequency discharges, thermonuclear effects, ionization in the upper atmosphere, and plasma oscillations and waves. Periodic tables, critical potentials, and physical constants are included in appendixes.

Literature Surveys on Influence of Stress Concentrations at Elevated Temperatures The Effects of Nonsteady Load and Temperature Conditions on the Creep of Metals

Published 1959 as ASTM Special Technical Publication No. 260 by the American Society For Testing Materials, Philadelphia, Pa. 104 p., 8½ × 11 in., paper. $4.50. The survey on stress concentration covers 1926–1957. It reviews the available notch-rupture data with the idea of establishing fundamental influences of stress concentrations, testing variables, and the influence of alloy compositions, and deals with the application of notch data to the problem of component design. The survey on cyclic loading covers 1937–1956, and describes the fundamental investigations, summarizes data on alloys under complex variations of load and temperature, and reviews several analytical procedures for calculating nonsteady behavior from steady-state stress tests.

Marine Lubrication

By G. H. Clark. 1959, Simmons-Boardman Publishing Corporation, New York, N. Y. 635 p., 6¼ × 9¼ in., bound. $16. This book describes the properties, refining, testing, and filtration of lubricating oils, the fundamental principles of their use, and the prime movers in which they are used, dealing specifically with the marine power plant and its auxiliary machinery, which have similar lubricating requirements whether used on land or sea. Machinery described includes diesel engines, steam engines, turbines, pumps, compressors, refrigerating, steering, and deck machinery, and their fuels.

Mechanical Radiation

By Robert Bruce Lindsay. 1960, McGraw-Hill Book Company, Inc., New York, N. Y. 415 p., 6¼ × 9¼ in., bound. $10. A graduate-level introduction to wave motion using mechanical radiation as the principal vehicle, but emphasizing those aspects common to all kinds of wave propagation. Included are radiation aspects of acoustics such as elastic radiation in bounded solids, absorption and dispersion in fluids, magnetohydrodynamics, macroscopic, and microscopic aspects of mechanical filtration, and the relation of elastic radiation and other properties of matter.

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Modern Probability and Its Applications

By Emanuel Parzen. 1960, John Wiley & Sons, Inc., New York, N. Y. 464 p., 6 × 9¼ in., bound. $10.75. This book introduces the concepts and ideas of both discrete and continuous probability theory, giving applications to real phenomena, and demonstrating techniques for problem solution. The first eight chapters require little mathematical background and deal with elementary theory. The final two chapters are less elementary, with rigorous derivations and new proofs relative to the roles in probability theory of the law of large numbers, limit theorems, and characteristic functions.

Monorails

By Hermann S. D. Botzow, Jr. 1960, Simmons-Boardman Publishing Corporation, New York, N. Y. 104 p., 5¾ × 8¾ in., bound. $3.95. This brief survey of monorail transportation opens with an historical account, and then discusses types of monorails, cars, track, structures, location and construction, operating characteristics, wayside equipment, and the economics of this means of transportation. There are very useful appendixes, including chronological lists of constructed and proposed monorail systems, a tabulation of the dimensions and other characteristics of cars in use, diagrams of rail cross section and rail supports, and an extensive bibliography.

Principles of Petroleum Geology

By William L. Russell. Second Edition. 1960, McGraw-Hill Book Company, Inc., New York, N. Y. 503 p., 5½ × 9¼ in., bound. $9.50. This survey discusses the important principles, processes, and techniques, and the future prospects, of all aspects of petroleum geology. This edition includes much new material on the origin and accumulation of petroleum, reservoir conditions, incipient metamorphism, and well logging. The book emphasizes those characteristics of oil and gas fields which facilitate their location.

Problems of Low Temperature Physics and Thermodynamics

(Proceedings of the Meeting of Commission 1 of the International Institute of Refrigeration, Delft, 1958.) Published 1958 by Pergamon Press, Inc., New York, N. Y., 341 p., 6½ × 9¾ in., bound. $11.50. The 48 papers included in this volume also appeared in the Annexe (Supplement) 1958–1 to the Institute's *Bulletin*. General subjects treated are cryogenic apparatus, thermometry, the disturbed crystal lattice, transport phenomena in liquids and gases, and the application of low temperatures in nuclear physics. The range of individual topics is from refrigeration systems, apparatus, and measurement to behavior and properties of silica glass, sodium, face-centered cubic metals, and gases at low temperatures. Theory, experiments, observations, methods, and instrumentation are all considered.

Proceedings of the Symposium on Millimeter Waves (Microwave Research Institute Symposia Series, Vol. 9)

Sponsored by the Polytechnic Institute of Brooklyn. 1960, Interscience Publishers, Inc., New York, N. Y. 656 p., 6 × 9 in., bound. $8. The 40 papers here published include nine not presented at the symposium. Participating were scientists from England, France, Japan, Israel, The Netherlands, the U.S.S.R., and the U.S.A. The papers discuss the present state of the use of millimeter waves in such fields as physics, communication, solid-state research, and metallurgy; dielectric, power, and electron profile measurements; the generation of millimeter and submillimeter waves by undulator, Cerenkov, and Purcell radiation, as well as by other means; multimodes and components; and future trends and applications of millimeter wave research.

Progress in Semiconductors, Vol. 4

Edited by Alan F. Gibson & others. 1960, John Wiley & Sons, Inc., New York, N. Y. 291 p., 6¼ × 9¼ in., bound. $10.50. This fourth volume in the series contains papers from the Soviet Union, England, Germany, Holland, Japan, and the United States. The scope of the discussions is shown by the titles of the papers: negative effective masses in semiconductors; oxidation phenomena on germanium surfaces; theory of avalanche multiplication in nonpolar semiconductors. internal-field emission; noise in semiconductors; the electrical effects of dislocations in semiconductors; dielectric properties of solids in relation to imperfections; noncrystalline, amorphous, and liquid electronic semiconductors.

Process Engineering Calculations

By Mack Tyner. 1960, The Ronald Press Company, New York, N. Y. 402 p., 6¼ × 9¼ in., bound. $8.50. The concern of this book is the application of the laws of conservation of matter and of energy to the solution of industrial chemical-process problems by the freshman engineering student. The principles of process material and energy balance are applied here to the feed preparation, chemical reaction, and separation steps of industrial processes, but are applicable to all process operations.

Progress in Solid Mechanics, Vol. 1

Edited by I. N. Sneddon and R. Hill. 1960, Interscience Publishers, Inc., New York, N. Y. 448 p., 6¼ × 9 in., bound. $15.50. This first of a proposed series reviews recent theoretical studies. The eight chapters by various authors discuss viscoelastic waves; matrices of transmission in beam problems; dynamic expansion of spherical cavities in metals; general theorems for elastic-plastic solids; dispersion relations for elastic waves in bars; the dynamical theory of thermoelasticity; continuous distributions of dislocations; asymmetric problems of the theory of elasticity for a semi-infinite solid and a thick plate.

Surface Effects on Spacecraft Materials
Edited by Francis J. Clauss. 1960, John Wiley & Sons, Inc., New York, N. Y. 404 p., $8^3/_4 \times 11^1/_4$ in., bound. $11.50. These are the transactions of the first symposium on the requirements of materials for temperature-control surfaces of spacecraft and the behavior of material surfaces in space. Methods of calculation and measurement are first presented; the remainder of the book deals with the effects of space on the surface and structural properties of materials, and covers the sublimation of material into ultrahigh vacuum, the effects of high vacuum on mechanical properties, friction and wear under ultrahigh vacuum, ultraviolet radiation in space, interplanetary dust distribution, and atomic and molecular sputtering.

ASME BOILER AND PRESSURE VESSEL CODE

Interpretations

The Boiler and Pressure Vessel Committee meets regularly to consider "Cases" where users have found difficulty in interpreting the Code. These pass through the following procedure: (1) Inquiries are submitted by letter to the Secretary of the Boiler and Pressure Vessel Committee, ASME, 29 West 39th St., New York 18, N. Y.; (2) Copies are distributed to Committee members for study; (3) At the next Committee meeting interpretations are formulated to be submitted to the ASME Board on Codes and Standards, authorized by the Council of the Society to pass upon them; (4) They are submitted to the Board for action; (5) Those which are approved are sent to the inquirers and are published in MECHANICAL ENGINEERING.

(The following Case Interpretations were formulated at the Committee meeting June 24, 1960, and approved by the board on Aug. 29, 1960.)

Errata

Case 1254-1

In the last sentence of the Reply, revise reference to Par. UA-51(b)(3) to Par. UHA-51(b)(3).

Annulment of Cases

Case 1173-2

Essence of Case included in Section VIII (June 10, 1960, Addenda).

Case 1194-1

Essence of Case included in section VIII (June 10, 1960, Addenda).

Case 1204-5 (*Special Ruling*)
Quenched and Tempered Steel

In PAR. 6 of the Inquiry revise Table 2 to read:

Table 2 Tensile Requirements

	Up to 2 in. Incl.	Over 2 in. to $2^1/_2$ in.
Tensile strength, psi min.	115,000 to 135,000	105,000 to 135,000
Yield strength, psi min.	100,000	90,000
Elongation 2 in. min. per cent	18	18

In Par. 7 of the Inquiry revise the last line of Table 3 to read: Over 1 inch to $2^1/_2$ inches inclusive.

In Par. 1 of the Reply, revise 2 inches to $2^1/_2$ inches.

In Item 4 of the Reply, revise to read: (4) The maximum allowable stress value shall be 28,750 psi for plates 2 in. and under and shall be 26,250 psi for plates over 2 in., to $2^1/_2$ in., inclusive.

Case 1270N-2 (*Special Ruling*)
General Requirements for Nuclear Vessels

Item 3 of the Reply revise to read as follows:

3(a) All longitudinal and circumferential welded joints of vessels defined in 5(a), (b), and (d) built under this and subsequent cases dealing with nuclear vessels, shall be of the double-welded butt-type (or its equivalent as defined in Pars. UA-60(o) and P-101(c)) except that circumferential joints between vessel sections forming transitions in diameters may be angle joints; provided, the angle formed between the members being joined does not exceed 30 degrees. All longitudinal, circumferential, and angle joints shall be fully radiographed. Vessels fabricated of carbon or low-alloy steel shall be stress-relieved except as otherwise provided in Case 1272N.

(b) Those portions of vessels defined in 5(b) not in direct contact with primary coolant and those vessels defined in 5(c) shall be built in accordance with Section I or VIII of the Code, but need not meet the special provisions of Code Case 1270N, 1271N, 1272N-1, and 1274N-1 except that all longitudinal and circumferential welded joints of such vessels shall be fully radiographed.

5(b) revise to read:

5(b) Primary vessels are those vessels, other than the reactor vessels, which are an integral part of the primary coolant system during normal operation and which contain or may contain coolant at the operating conditions of radioactivity level, pressure, and temperature.

5(c) Delete the last sentence.

Case 1273N-2 (*Special Ruling*)
Nuclear Reactor Vessels and Primary Vessels

Delete Par. 10 of the Reply.

Case 1274N-2
Special Material Requirements

Add the following as new paragraph (3) to the Reply:

(3) Alloy-steel bolting, including studs and nuts, made of material conforming to ASTM Specification A 437-59T may be used in the construction of nuclear vessels using maximum allowable design stresses in accordance with Par. (3) of the Reply to Case 1273N. The extension caused by bolt tightening shall be measured by means of extensometers.

Case 1275-N (*Special Ruling*)
Inspection Requirements

Inquiry: How shall the ultrasonic inspection of welded joints, which is required by the Code rules for nuclear vessels, be performed?

Reply: It is the opinion of the Committee that the ultrasonic inspection of welded joints which is required by the Code rules for nuclear vessels shall be made and interpreted in accordance with the following requirements.

1 Selection and Adjustment of Ultrasonic Inspection Testing Equipment

(a) The instruments used for weld inspections shall be capable of giving indications whose over-all heights vary in proportion to variations in the size of the areas reflecting the ultrasound. Such response can be expected only within the designed limits of the equipment and within the viewing area of the cathode ray tube or other indicating instrument, while equal distances are maintained between the transducer and interface.

(b) The performance and sensitivity of the ultrasonic equipment, including both the accoustical and the electronic circuits and all components used during the examination shall be tested as follows, using the Standard Ultrasonic Reference Plate (see Par. 7) as a contact surface:

(1) Direct the shear wave toward Hole C ($^1/_{16}$ in. diam $\times$ 0.050 in. deep) with a distance of approximately 3 in. between Hole C and the transducer.

(2) Adjust the reflection from Hole C to 20 per cent of a full (100 per cent) reflection.

(3) Without making any instrument changes, turn the transducer so that the shear wave is directed toward Hole B, ($^1/_{16}$ in. diam × 0.250 in. deep), and move the transducer until it is the same distance from Hole B that it previously was from Hole C.

(4) The reflection from Hole B shall be a 100 per cent reflection. Note: If different results are obtained, the equipment is not in satisfactory condition for the examination.

(c) *Reference Weldment* One or more reference weldments shall be prepared, with a weld length of at least 8 in. and a plate width of at least 6 in. on each side of the weld of similar material and maximum thickness to be encountered in the weldment to be inspected. These references may be used for any weldments of similar materials within the thickness limitations established by the reference weldments. A portion of either the procedure qualification or operator qualification test plates may be used if it fulfills the foregoing requirements. The reference hole may be drilled in the object to be examined, in lieu of the reference weldment, provided such drilling will not affect its serviceability.

A hole shall be drilled normal to the plate at a distance not less than two inches from both the weld and the edges of the plate. If the base metal exceeds $^1/_2$ inch in thickness, the hole shall be drilled to a depth of $^1/_2$ inch; for thinner plates the hole shall be drilled through the plate. The diameter shall be $^1/_{16}$ inch for plate 2 inches thick and less, and $^1/_{16}$ inch larger for each 2 inch increase in thickness. Where two thicknesses are involved, as in the case of nozzle attachments, the reference thickness shall be that to which the search unit is applied.

(d) *Couplants* A satisfactory couplant which is capable of transmitting vibrations and which will exclude air shall be used for contact inspections.

The distance between the transducer and the weldment in liquid-coupled inspections shall be adjusted to show both the near and far sides of the deposited weld metal.

(e) *Shear Wave Testing* The level of sensitivity of the instrument shall be adjusted so that the height of reflection or signal from the reference hole, in a Reference Weldment described in (c) for the thickness being examined, produces a 100 per cent reflection on the cathode ray tube or other indicating instrument when the distance between the transducer and the hole is the same as the transducer-to-weld distance to be used during the inspection.

Shear wave transducers giving refracted incident angles of 45 to 85 degrees are normally used, the selection of the angle being dependent on either or both the thickness and the geometry of the weldment. Shear wave transducers of 70 to 85 degrees may generate Rayleigh surface waves as well as shear waves; therefore, it is important that the possibility of surface wave be considered when using these transducers (Note 1). Transducers with a beam angle less than 45 degrees may be used if the geometry of the weldment is more adaptable to the smaller angle.

Note 1. In relatively thin materials, in the order of a wave length or less, Lamb waves may be generated. This procedure does not cover Lamb waves in detail.

A frequency of 1.0 megacycle is generally satisfactory for welds in materials of $^1/_2$ inch or over in thickness and a frequency of 2.25 megacycle shall be used for welds in materials less than $^1/_2$ inch thick. One square inch transducers are generally used. Other frequencies and other sizes may be used if mutually agreed upon by the manufacturer and the inspector.

(f) *Longitudinal Wave Testing* The practice shall be in accordance with ASTM Specification E 114-55T and shall conform to the applicable portions of this Case.

(g) The reflection from the hole in the Reference Weldment shall be referenced to the Standard Ultrasonic Reference Plate to enable future examinations at the same level of sensitivity.

2 Preparation of Welds for Ultrasonic Examination

(a) The weld ripples or weld surface irregularities on both the inside and the outside shall be removed by any suitable mechanical process to such a degree that the resulting ultrasonic indications from any remaining irregularities cannot mask or be confused with indications from any objectionable defects. Also, the deposited weld metal shall merge smoothly into the plate surface. The finished surface of the reinforcement of butt welds may be flush with the plate or have a reasonably uniform crown not greater than the values given in Par. UW-51(b).

(b) The base material surfaces to be used for inspection shall be free from weld spatter and extreme roughness on one or both sides of the weld for a distance equal to three times the thickness of the base material or 6 inches from the centerline of the weld, whichever is greater.

(c) Weld backing strips shall be removed and all sharp edges and valleys shall be eliminated by grinding or other mechanical means.

3 Sheer Wave Contact Inspection Procedure

(a) Nozzle, branch, other attachment welds, longitudinal and circumferential joints, and other full penetration welds requiring inspection may be examined from one or both sides and usually from only one surface, but conditions may require a more complete investigation from both surfaces. The reference thickness shall be that of the thickness to which the search unit is applied.

(b) The transducer shall be moved slowly toward and away from the weld for a distance sufficient to cover the entire cross-section of the weld metal. The speed of motion will depend on the operator's ability to clearly see and identify all reflections.

(c) Because of the directional properties of shear waves, the direction of the transducer shall be kept at 90 deg. from the centerline of the weld, except that it shall be turned continually through a few degrees alternately to each side of 90 deg. during its movement to detect flaws unfavorably oriented.

(d) While being moved slowly sideways, the transducer shall be advanced in a direction parallel to the centerline of the weld at a rate which will permit the operator to clearly define the reflections.

(e) The cathode ray tube shall show small structural reflections from the parent metal on the side of the weld opposite to the transducer. The locations of such small reflections on the cathode ray tube, or other indicating instrument, change with any movement of the transducer. If these reflections are not present, satisfactory contact is lacking between the transducer and material under examination, or the frequency is incorrect or other faults exist, and the test is to be considered unsatisfactory.

(f) When the weld surface is smooth and satisfactory contact can be made, the transducer may be moved along the top of the weld metal with the ultrasonic energy beamed parallel to the centerline of the weld to inspect for flaws transverse to the weld centerline and for cracks in the base metal. Movement of the transducer shall not exceed a rate which enables the operator to identify all reflections.

(g) When satisfactory contact with weld metal cannot be made or when the heat-affected zone of the base metal is to be inspected for cracks resulting from welding, the contact surface shall be the base metal immediately adjacent to the

weld metal. The transducer shall be directed at angles of between 30 and 60 deg. from the centerline of the weld. The transducer shall be moved forwards and backwards over a distance equal to several times the base metal thickness. The transducer shall be advanced parallel to the weldment centerline at a rate enabling the operator to identify all reflections.

(h) When conditions permit, nozzle and flange-to-shell welds may be inspected from the flange surface with a longitudinal wave in accordance with ASTM Specification E114-55T. This latter procedure sometimes enables simultaneous inspection of the flange-to-pipe and pipe-to-shell butt welds, depending upon the ultrasonic penetration.

(i) Inspection of fillet welds, attachment welds, and other welds not requiring full weld penetration shall be in accordance with (a), (b), (c), and (d). Good ultrasonic penetration (see (e)) through the deposited metal and into the parent metal on the opposite side of the weld from the transducer shall be obtained.

4 Standards for Ultrasonic Inspection

(a) Any crack, lack of fusion, incomplete penetration, inclusion, or cavity which gives a reflection equal to or greater than 80 percent of the Reference Hole reflection and has a linear dimension (or "travel") exceeding 1/4 inch is unacceptable.

Note: The above does not include "point" indications whose reflections are lost with any movement of the transducer.

(b) In the event any interpretation is doubtful, the questioned area may be examined by other non-destructive testing methods.

5 Repair Welding

(a) All rewelded and repaired areas shall be re-examined ultrasonically and shall conform to the requirements of Par. 4 to be acceptable.

6 Final Test and Reporting

(a) The inspector shall witness the final ultrasonic test, check any portion or assist with the complete test unless the inspector specifically waives this requirement.

(b) The manufacturer shall prepare a report of the final ultrasonic inspection which shall include:

(1) The ultrasonic inspection data outlined in Par. 4 including instrument setting, height of general indications from parent metal and deposited metal.

(2) The manufacturer's job number, the vessel, the seam, and the manufacturer's identification symbol or name shall show plainly on each plot or tape.

(3) A drawing or sketch containing a physical outline of the weldment with location of welds, location of flaw indications and locations of repaired areas.

(4) An acceptance record shall be maintained of all reflections from uncorrected areas exceeding 60 percent of the full reflection from the reference hole in the Reference Weldment. This record shall locate the reflection in relationship to the identification symbol, give its magnitude on the cathode ray tube, or other indicating instrument, its transverse and longitudinal length, its depth or height when possible to measure, and the operator's interpretation of the reflection.

7 Standard Ultrasonic Reference Plate for Pulsed, Single Transducer Testing Instruments and Accessories Using Longitudinal or Shear Ultrasonic Waves for the Examination of Welded Joints (Fig. 1)

(a) *Purposes:*

(1) To provide a reference which enables 3 reproducible levels of instrument sensitivity for both longitudinal and shear wave examinations and thus enable future re-examinations at the same level of sensitivity.

(2) To provide known measured areas for approximating the magnitude of faults or defects which are so small that their reflections are lost when the search unit is moved in any direction. (The depth and extent or outline can be determined if the reflection can be retained during movement of the search unit.)

(b) *Material:* The Reference Plates shall be of clean, good quality, fine grain steel.

Note: The material should be ultrasonically examined prior to fabrication to assure the rejection of any unsatisfactory material.

(c) *Drawing:* The plate shall be fabricated in accordance with the sketch shown, Fig. 1.

(d) *Artificial Defects of Known Measurements:* The Reference Plate shall contain the following flat bottomed holes:

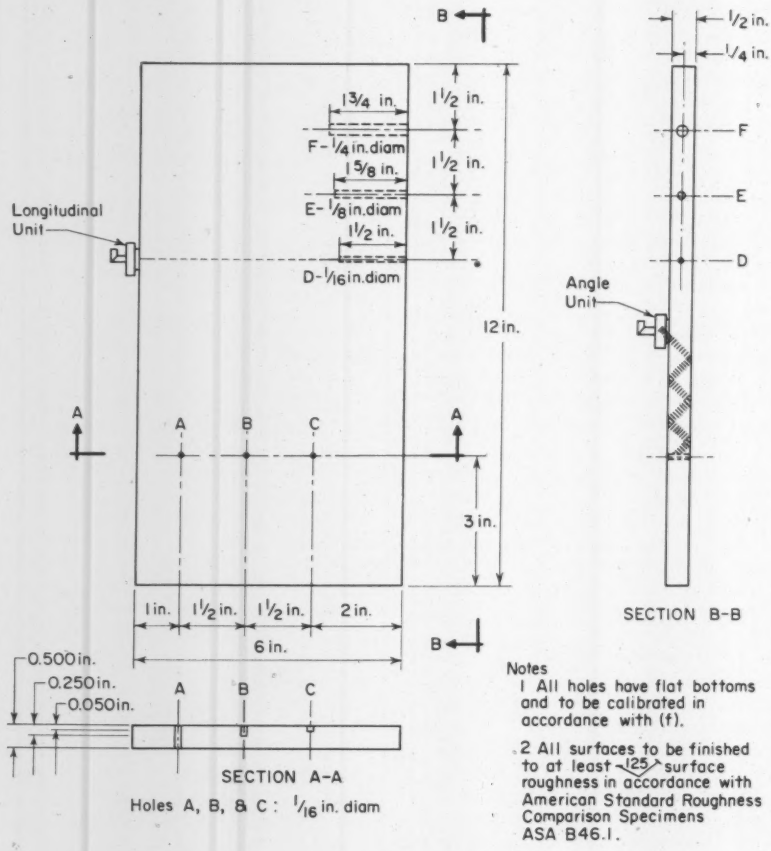


Fig. 1 Standard Ultrasonic Test

	Diameter	Depth	Position in Direction to Top Surface
*A	1/16 in.	.500 in.	Vertical
B	1/16 in.	.250 in.	Vertical
C	1/16 in.	.050 in.	Vertical
D	1/16 in.	1.500 in.	Horizontal
E	1/8 in.	1.625 in.	Horizontal
F	1/4 in.	1.750 in.	Horizontal

* Entirely through plate.

(e) *Machining and Surface Finish:* All six sides of the Reference Plate shall be ground to a surface finish of at least 125 micro-in.

(f) *Calibration:* The shear wave reflections from holes A, B, and C and the longitudinal reflections from holes D, E, and F shall be compared and the holes altered if necessary to give reflection equal (within 5%) to similar holes in any calibrated Ultrasonic Reference Plate, in accordance with Fig. 1.

(g) *Marking:* The depth of the vertical holes (A, B, and C) and the area of the horizontal holes (D, E, and F) in square inches of each hole shall be clearly stencilled on the edges of the Plate.

(h) *Identification:* Each calibrated Ultrasonic Reference Plate shall be stencilled with an Ultrasonic Reference Plate Identification by the manufacturer after the Plate has been satisfactorily calibrated in accordance with Fig. 1.

Case 1284

(Special Ruling)

H Grades of Austenitic Stainless Steels

Inquiry: Under what conditions may the H Grades of austenitic stainless steel, types 304, 316, 321, 347, and 348 be used in Code constructions?

Reply: It is the opinion of the Committee that the "H" Grades of austenitic stainless steel, types 304, 316, 321, 347 and 348 may be used in Code constructions under the following conditions:

(a) The material shall be in accordance with one of the following specifications, SA-182, SA-213, SA-249, and SA-312 or SA-376.

(b) The allowable stresses at 1000 F and above shall be the same as the S values listed in Tables P-7 and UHA-23 for the regular grades of these types in the above specifications.

Case 1286

(Special Ruling)

Bolts and Nuts of the Same Material SA-307

Inquiry: Is it permissible to use nuts in accordance with Specification SA-307 with bolts conforming to that specification?

Reply: It is the opinion of the Committee that it will meet the intent of the Code if nuts conforming to Specification SA-307 are used with bolts conforming to that specification provided that the nuts comply with the requirement of Par. UCS-11(c) of Section VIII.

Proposed Revisions and Addenda to Boiler and Pressure Vessel Code . . .

As need arises, the Boiler and Pressure Vessel Committee entertains suggestions for revising its Code. Revisions approved by the Committee are published here as proposed addenda to the Code to invite criticism. If and as finally approved by the ASME Board on Codes and Standards, and formally adopted by the Council, they are printed in the semi-annual addenda supplements to the Code. Triennially the addenda are incorporated into a new edition of the Code.

In the following the paragraph numbers indicate where the proposed revisions would apply in the various sections of the Code.

Power Boilers, 1959

Par. P-3(2)

Add a footnote designation 1 to Specification SA-53 and add a footnote 1 to read: Furnace lap welded grades in this specification are excluded.

Par. P-11

Add a footnote designation 1 to Specification SA-53 and add a footnote 1 to read: Furnace lap welded grades in this specification are excluded.

Table P-7

Under Pipe and Tubes Lap Welded, delete Specification SA-53 and its stress values.

Table P-7

Add the stress values for Specification SA-430

Par. P-26

The revision to this paragraph shown in June, 1960 Mechanical Engineering has been withdrawn for further consideration and will not be included in the Pink Sheet Addenda.

Par. P-300

Sixth paragraph, revise the reference to Forms P-2 or P-3 to read Form P-4A.

Form P-4A

Under Certificate of Field Assembly revise first part of first line to read: We certify that the field assembly of the described piping conforms with . . . . .

In the third line revise (A) or (S) to read (A), (S) or (PP).

In the sixth, seventh and ninth lines, revise the words described boiler to read described piping.

Material Specifications, 1959

The Boiler and Pressure Vessel Committee approved adding to Section II the following new specifications:

SA-264-59T Corrosion-Resisting Chromium-Nickel Steel Clad Plate, Sheet and Strip.

A notation is added stating that this specification is identical to ASTM Specification A 264-59T except for the heat treatment clause in Par. 3 which shall be in accordance with the requirements of SA-264-44T.

SA-430-59T Austenitic Steel Forged and Bored Pipe for High-Temperature Service (H Grades only)

Maximum Allowable Stress Values for Ferrous Materials Pounds per Square Inch to Be Added to Table P-7 and Table UHA-23

Spec. Number	Grade	Nominal Composition	Spec. Min. Tensile	Notes	For Metal Temperatures Not Exceeding Deg F: −20 to 100	200	300	400	−20 to 400
Plate Steel									
Forged & Bored Austenitic Stainless Steel									
SA-430	FP304H	18 Cr-8 Ni	70000	(7)	17500	15850	14950	14400	...
SA-430	FP304H	18 Cr-8 Ni	70000	...	17500	15850	14800	13650	...
SA-430	FP321H	18 Cr-10 Ni-Ti	70000	...	17500	17500	15850	14750	...
SA-430	FP347H	18 Cr-10 Ni-Cb	70000	...	17500	17500	15850	14750	...
SA-430	FP316H	18 Cr-10 Ni-3Mo	70000	...	17500	17500	16700	16350	...

Grade	For Metal Temperatures Not Exceeding Deg F: 500	600	650	700	750	800	850	900	950	1000
FP304H	14100	13900	13850	13800	13700	13600	13350	13050	12800	12500
FP304H	12500	11600	11200	10800	10400	10000	9700	9400	9100	8800
FP321H	14200	13900	13850	13800	13700	13650	13600	13600	13550	13500
FP347H	14200	13900	13850	13800	13700	13650	13600	13600	13550	13500
FP316H	16050	15950	15900	15850	15800	15650	15400	14950	14500	14000

Grade	For Metal Temperatures Not Exceeding Deg F: 1050	1100	1150	1200	1250	1300	1350	1400	1450	1500
FP304H	10000	7500	5750	4500	3250	2450	1800	1400	1000	750
FP304H	8500	7500	5750	4500	3250	2450	1800	1400	1000	750
FP321H	13100	10300	7600	5000	3300	2200	1500	1200	900	750
FP347H	13100	10300	7600	5000	3300	2200	1500	1200	900	750
FP316H	12200	10400	8500	6800	5300	4000	2700	2000	1500	1000

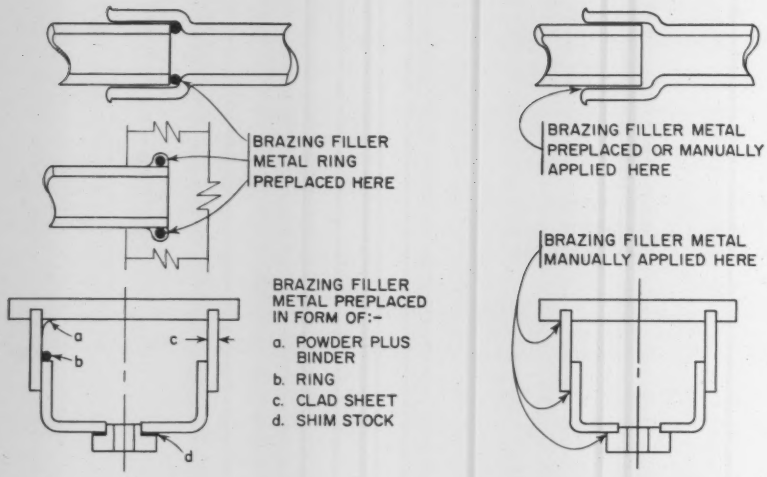


Fig. UB-14 Examples of filler metal application

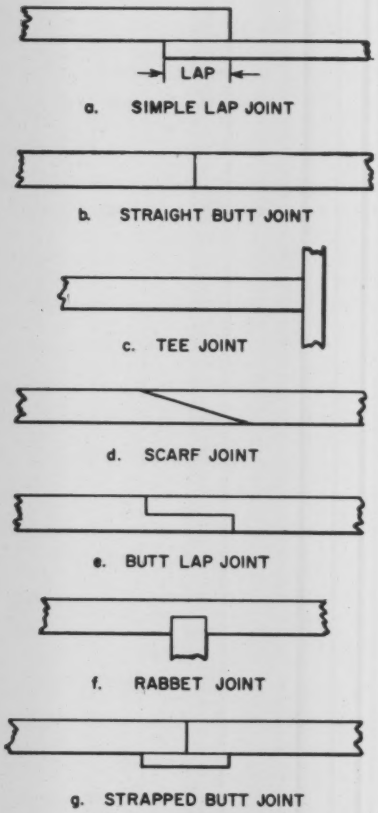


Fig. UB-16 Some acceptable types of braze joints (other equivalent geometries yielding substantially equal results also are acceptable)

Unfired Pressure Vessels, 1959

PAR. UB-14(a)

Add at the end of paragraph: (See Fig. UB-14(a)).

Par. UB-14(b)

At end of paragraph add a parenthetical statement before the existing parenthetical statement to read: (See Fig. UB-14(b)).

FIG. UB-14

Examples of Filler Metal Application, add this new Fig. UB-14.

FIG. UB-16

Some Acceptable Types of Braze Joints, add this new Fig. UB-16.

PAR. UB-16(b)

Revise to read:

The nominal thickness of base material used with lap joints tested using the test fixture shown in Fig. QB-8(a) shall not exceed $^1/_2$ inch. There is no thickness limitation when specimens are tested without the test fixture shown in Fig. QB-8(a).

PAR. UB-31(a)

In second line revise the wording Par. UB-17 to read: Par. UB-18.

PAR. UB-37

Revise the second paragraph to read:

When a repair brazing procedure is established it shall provide control of the application of brazing filler metal to meet the conditions set forth in Par. UB-14(a). Where these requirements cannot be met, the limitations of Par. UB-14(b) will apply.

PAR. UB44(a)

In last line revise the wording Pars. UB-2(a) and UB-14(d) and (e) to read: Par. UB-15(b) and (c).

PAR. UA-50

Revise to read:

(a) The flange stresses calculated by the formulas in Par. UA-51 shall not exceed the following values (see Note 5):

(1) Longitudinal hub-stress S_H not greater than S_f for cast iron and, except as otherwise limited by (1a) and (1b), not greater than 1.5 S_f for materials other than cast iron.

(1a) Longitudinal hub-stress S_H not greater than the smaller of 1.5 S_f or 1.5 S_n for optional-type flanges designed as integral (Fig. UA-48(8), (8a), (8b), and (9)), also integral type (fig. UA-48(7)) where the neck material constitutes the hub of the flange.

(1b) Longitudinal hub-stress S_H not greater than the smaller of 1.5 S_f or 2.5 S_n for integral-type flanges with hub welded to the neck, pipe or vessel wall (Fig. UA-48(6), (6a) and (6b)).

(2) Radial flange stress S_R not greater than S_f.

(3) Tangential flange stress S_T not greater than S_f.

(4) Also $\frac{S_H + S_R}{2}$ not greater than S_f

$$\frac{S_H + S_T}{2} \text{ not greater than } S_f$$

Note 5: (use present wording)

(b) (use present text)

(c) Change S_f to S_n in fifth line of present text.

TABLE UA-51

Delete "or nozzle neck" from definition of S_f.

Add S_n = allowable design stress for material of nozzle neck, vessel or pipe wall pounds per square inch (given in Subsection C).

PAR. UG-84(c)(2)

Revise $^7/_{16}$ inch to read $^1/_2$ inch in the last sentence.

PAR. UG-84(d)(1)

Delete last sentence.

TABLE UHA-23

Add the stress values shown for Table P-7.

Current Engineering Events, News, and Comment

E. S. NEWMAN
News Editor

THE ROUNDUP

Rufus Oldenburger Reports on Automatic Control Education in USSR

THREE phases of the development of automatic control in the Soviet Union are now evident, reports Rufus Oldenburger, who served as the chairman of the U. S. Delegation to the International Federation of Automatic Control, Moscow Congress, June 27–July 2, 1960. Phase one is the education of control specialists and the development of a large body of fundamental automatic control theory. This phase appears to be finished, although these functions will continue to be carried on at a high level in the future. Emphasis is now on phase two, which is the bridging of the gap between theory and industry. To this end the Russians have created a number of automation institutes. In five or ten years Russia may be expected to enter phase three, namely, the period of general industrial automatic control.

Dr. Oldenburger, Mem. ASME, Professor of Mechanical Engineering, Purdue University, stated that the Russians are graduating 5000 college seniors a year in the general area of automatic control. These people now receive eight years of elementary school training followed by three years of high or "middle" school. The average student entering college is 18 years old.

Educational Procedure. After high school there are days of "open door" (in our country we call this "open house") when students may visit automatic control institutes and apply for such vacancies as exist. A comprehensive entrance examination is required for admission. If a student fails, he may try again in a year. If he fails the second time, he may try again in another year. This process may be continued until he is 35 years old. He is then eligible only for study in a correspondence or evening school. Between 10 and 12 students apply for each college opening in automatic control. If accepted, attendance at classes is required. Each college opening corresponds to an existing or future job in Soviet industry or government.

In college-level institutes there is often one, and only one, chair of automatic control. Almost all institutes require two and one-half to three years of general education. Of the five and one-half years a student normally spends in the institute, five are given over to theoretical studies and associated laboratories, whereas the last one-half year is devoted to a practical project. This project may involve research. Regardless of the nature of the project, at the end of the half year the student must defend his work. An average student is $23\frac{1}{2}$ years old when he receives his college diploma. From 35 to 40 per cent of automatic control students are women.

Curriculum. The first year at the institute the student must choose his subspeciality of automatic control such as chemical-process control. Contrary to his American counterpart, he must thus select his life work early. In his basic education he takes two years of physics, two of mechanics, four of English, German, or French, one year of chemistry, one-half year of political economy, three years (depending on the institute) of mathematics, two years of strength of materials, one-half year of applied mechanics and machine design, one and one-half years of electrical theory, one year of drawing, one-half year of hydraulics, and one year of electrical measurements.

The government supplies funds for the support of this program on the basis of a seven-year plan, modified each year.

Postgraduate Work. After graduation the average student must devote at least two years to a job in industry or research before he is permitted to resume his studies. About 5–10 per cent of these graduates return for advanced work. From 3–5 per cent of the graduating students with the best academic records are permitted to skip the two years of work. However, they must pass entrance examinations to enter graduate school.

Normally, students work three years after college toward the master's degree. A master's student must write a dissertation which the institute publishes and which the student is called upon to defend. The faculty adviser makes major decisions. The thesis must contain some new work, must show that the man can do research and direct the re-

Praesidium of plenary session, opening IFAC Congress, June 27, 1960, Great Hall, Moscow University, Lenin Hills, **left to right:** A. N. Kosigin, First Vice-Premier of USSR; A. Nesmeyanov, president, USSR Academy of Sciences; Rufus Oldenburger, Mem. ASME and chief of U. S. A. delegation; Victor Broida, member, IFAC Executive Council; G. Ruppel, IFAC secretary; and E. R. Willems, chief Belgium delegate

search of others. If he passes this stage successfully, the student becomes a "candidate."

About 10 per cent of the candidates study for the doctor's degree. These degrees are doctors of science rather than PhD's. These students do not attend lectures, but concentrate on their theses and must work on their own entirely without assistance. Important new results are expected, or a good textbook, or a fundamental survey. The government supplies stipends to all college and graduate students except candidates for the doctor's degree. These candidates receive no financial assistance unless they hold jobs in industry or teaching.

The College Pays! Students pay no fees. The stipend received by a college student depends on his specialty and marks. The first year he receives 300 to 400 rubles a month (10 rubles to $1 tourist rate of exchange, and 50 to $1 on the black market), 500 if his marks are high. The second year he receives 390 rubles a month on the average, and gets 40 or 50 more each year. He pays 30 to 40 rubles a month for his room in a dormitory, sharing this with one to four other students. From five to six rubles is said to be enough to pay for a day's food in the dining room.

A brilliant master's student will receive 700–800 rubles a month. After two years he may be paid 1000 rubles or more. Doctors students are paid 1800 to 3200 rubles a month. After receiving the doctor's degree, a man's salary is increased to 4000 rubles a month or more. To secure a job in a factory, where such a man will often find employment, he must apply to the appropriate factory committee.

Institutes are well provided with servo equipment. In both education and research institutes this equipment is often crowded into extremely small space. In spite of such handicaps, the Russians are succeeding in producing well-trained control engineers and scientists at much faster rate than in the United States. Most of these scientists and engineers appear to be going into the Soviet military establishment.

T. A. Marshall, Jr., Leaves ASME, October 15, to Serve as ASTM Executive Secretary

Thomas A. Marshall, Jr., who has been Senior Assistant Secretary of The American Society of Mechanical Engineers since 1957, recently resigned that post to accept the position of Executive Secretary of the American Society for Testing Materials. Mr. Marshall will leave ASME October 15 to assume his duties in Philadelphia, Pa.

Born in Savannah, Ga., Jan. 14, 1911, he was educated there and in June, 1932, was graduated from Georgia School of Technology (now Georgia Institute of Technology) with a BS degree in aeronautical engineering.

From December of 1932 until 1951, except for five years' active duty with the U. S. Navy during World War II, Mr. Marshall was employed in the home office of the Metropolitan Life Insurance Company, first in various capacities in stationary engineering and later in various capacities of increasing responsibilities in the Co-Ordination Division.

In 1951, at the time of its formation, he became Executive Secretary of the Engineering Manpower Commission, Engineers Joint Council, and in 1952 became Secretary of EJC as well.

Mr. Marshall joined the staff of ASME, in 1954, to manage the Society's 75th Anniversary Celebration and its public-relations activities. In 1956 he was made Head of Technological Service, which includes the Professional Divisions, national meetings and conferences, editorial department, and research activities of the Society. This led to his appointment as Assistant Secretary. In 1957 he was designated Senior Assistant Secretary.

His World War II record in the U. S. Navy included service as gunnery officer aboard the *USS Orizaba;* Executive Officer and Commanding Officer, *USS Saturn;* and Commanding Officer, *USS Lumen.* He also served as assistant engineer and Material Officer on the staff of Commander Service Force, U. S. Atlantic Fleet. When he was released to inactive duty, November, 1945, he held the rank of Commander.

His professional memberships in addition to ASME include ASEE, Human Factors Society, U. S. Naval Institute, Tau Beta Pi, Army and Navy Club, Georgia Tech Club of New York, The Engineers' Club of New York, NSPE, and the Engineering Institute of Canada. He is a registered PE in the State of New York.

As Executive Secretary of ASTM, Mr. Marshall will head a staff which supports a Society of 10,500 members and 6000 additional committee members. Through its organization of some 85 technical committees ASTM devotes its efforts to the stimulation of research and to the development of standard specifications and methods of test for materials.

ASTM announced that R. E. Hess, currently Acting Executive Secretary, will resume his duties as Associate Executive Secretary and continue as Technical Secretary and with continuing responsibilities for Editor-in-Chief. F. F. VanAtta, formerly assistant Secretary of ASTM, will assume the post of Treasurer with responsibility for business operations, and R. J. Painter, Mem. ASME, formerly Executive Secretary, will continue as consultant to the Executive Secretary.

PEOPLE

Honors and Awards. Dr. Hugh L. Dryden, Fellow ASME, of Washington, D. C., deputy administrator of the National Aeronautics and Space Administration, will receive the Elliott Cresson Medal from The Franklin Institute for his contributions to the theory and application of aerodynamics.

Charles P. McCormick, chairman of the board, McCormick and Company, Inc., Baltimore, Md., has received the Henry Laurence Gantt Medal, awarded annually by AMA and ASME, for distinguished achievement in management.

Richard R. Moore, chief metallurgist for the Naval Air Engineering Facility of the Naval Air Material Center at the Philadelphia Naval Base, will receive a certificate of merit from The Franklin

Institute. He developed a materials fatigue testing machine in 1924 that revolutionized metallurgical concepts. The Institute also will award Louis E. Levy Medals to EZRA S. KRENDEL of Swarthmore, Pa., and DUANE T. MCRUER of Inglewood, Calif., for their use of quantitative engineering to describe human behavior.

The Joint Chiefs of Staff have selected STEPHEN D. BECHTEL, SR., to receive the eleventh annual award of the National Defense Transportation Association for his contributions to pipeline transportation of petroleum and gas, which benefited the armed forces of the United States and its allies.

Appointments. NELSON R. DROULARD of Gwynedd Valley, Pa., formerly research and development director of Budd Company's automotive division, has been named technical director of mechanical and nuclear engineering at Franklin Institute Laboratories, Philadelphia, Pa. He succeeds FRANCIS L. JACKSON, Mem. ASME, who became assistant director of the laboratories in January.

Societe Royale Belge des Ingenieurs et des Industriels celebrates its 75th Anniversary. Photo taken in the Palace des Academies, Brussels, Belgium, June 21, 1960, during the formal ceremonies commemorating the occasion, which was graced by the presence of His Majesty Baudouin I, King of Belgium, shown in the box to the left. In the right box are the representatives of the EUSEC nations who extended the congratulations of their respective group to the Belgian Society. J. D. Wilding, assistant secretary, ASME, is in first row, second from left in box right.

MEETINGS OF OTHER SOCIETIES

●IN THE UNITED STATES

October 15–16

American Technion Society, third annual conference on science and technology in Israel and the Middle East, Hotel Astor, New York, N. Y.

October 16–19

American Water Works Association, southwest section annual meeting, Galvez Hotel, Galveston, Texas.

October 16–22

SMPTE, semi-annual convention and international high-speed congress and equipment exhibit, Sheraton Park Hotel, Washington, D. C.

October 17–19

TAPPI, 15th plastics-paper conference, Hotel Syracuse, Syracuse, N. Y.

October 17–21

National Safety Council, 48th National Safety Congress, Conrad Hilton Hotel, Chicago, Ill.

October 17–21

ASM, 42nd National Metal Congress, and metallographic exhibit, Philadelphia Trade and Convention Center, Philadelphia, Pa.

October 19

SPE, Tooling for the Plastics Industry, Hotel Commodore, New York, N. Y.

October 19

Fluid Power Society, first annual meeting, Sherman Hotel, Chicago, Ill.

October 19–21

Society for Experimental Stress Analysis, annual meeting, Claremont Hotel, Berkeley, Calif.

October 20–21

Illinois Institute of Technology, national conference on industrial hydraulics, Sherman Hotel, Chicago, Ill.

October 20–21

National Society of Professional Engineers, fall meeting, Hilton Hotel, Denver, Colo.

October 24–26

IRE, East Coast aeronautical and naval electronics conference, Baltimore, Md.

October 24–28

TAPPI, engineering conference, Robert Meyer Hotel, Jacksonville, Fla.

October 25–27

ASA, national conference on standards, Sheraton-Atlantic Hotel, New York, N. Y.

October 25–27

SAE, national transportation meeting, Hotel Leamington, Minneapolis, Minn.

October 25–28

NACE, south central regional meeting, Mayo Hotel, Tulsa, Okla.

October 26–28

AIEE, nonlinear-magnetics and magnetic amplifiers exhibits, Bellevue Stratford Hotel, Philadelphia, Pa.

October 27–28

ASID, 16th annual conference, Edgewater Beach Hotel, Chicago, Ill.

October 27–29

IRE, electron devices meeting, Shoreham Hotel, Washington, D. C.

October 31–November 1

SAE, national diesel engine meeting, Hotel Cleveland, Cleveland, Ohio.

October 31–November 2

AIEE, IRE, and ISA, 13th annual conference on electrical techniques in medicine and biology, Sheraton Park Hotel, Washington, D. C.

November 1–3

The Material Handling Institute, Inc., central states show, Kentucky Fair and Exposition Center, Louisville, Ky.

November 2–4

Society for Experimental Stress Analysis, annual meeting, Claremont Hotel, Berkeley, Calif.

November 3–4

SAE, national fuels and lubricants meeting, Mayo Hotel, Tulsa, Okla.

November 3–4

Louisiana Polytechnic Institute, annual instrumentation conference, LPI, Ruston, La.

November 9–11

AIEE, second power-industry computer-appli-

(*Continued on page 110*)

(*Continued from page 109*)

cation conference, Chase Hotel, St. Louis, Mo.

November 14–16

Steel Founders' Society of America, technical and operating conference, Hotel Carter Cleveland, Ohio.

November 14–18

ASTME, Western tool show and semi-annual convention, Ambassador Hotel and Los Angeles Sports Arena, Los Angeles, Calif.

November 15–17

IRE, Northeast research and engineering meeting, Boston, Mass.

●IN CANADA

October 17–18

Institute of the Aeronautical Sciences and Canadian Aeronautical Institute, joint meeting, Queen Elizabeth Hotel, Montreal, Quebec.

November 7

SPE, regional technical conference on automation in injection and compression molding, King Edward Sheraton Hotel, Toronto, Ontario.

●IN EUROPE

Mid-October

VDI-Fachgruppe Vibration Engineering, vibration conference, Essen, Germany.

October 17–19

K.I.v.I., International Congress on Plastics, Amsterdam, The Netherlands.

October 18–19

VDI-AWF-Fachgruppe Gear Engineering, international conference on gearing, Essen, Germany.

October 19–26

International congress and exhibition for instrumentation and automation, Dusseldorf, Germany.

●IN PAKISTAN

November 6–26

U. S. AEC, atomic energy exhibit, Lahore.

●IN INDIA

October 31–November 12

International Electrotechnical Commission, 25th general meeting, New Delhi.

(*For ASME Coming Events, see page 136*)

How the Research and Development Dollars Are Spent

Some 400 corporations representative of U. S. industry will spend an average of 10.7 per cent more for development of new products and processes in 1960 compared with 1959 according to a nation-wide, midyear survey by the American Management Association.

Of the 402 corporations representing 26 industry groups, 66 per cent increased their budgets, 7 per cent decreased their budgets, and 27 per cent reported no change.

Budget changes ranged from an average decrease of 11.8 per cent in mineral and coal mining and 5.2 per cent in publishing, to increases of 16.8 per cent in electronics and 22 per cent in miscellaneous machinery and parts.

Other leading industry increases in budgeted costs directly associated with development of new products and processes are: Glass, stone, and clay, 19.2 per cent; plastics and molded products, 14.6; public utilities, 14.3; instruments and control equipment, 14; and food and beverages, 13.1 per cent.

The 400 corporations spent an average of 3.7 per cent of 1959 sales for product development that year, the survey shows. The leading industry was electronics with 7.7 per cent, followed by instruments and control equipment, 6.1 per cent, and pharmaceuticals with 5.7 per cent.

Growth companies today are trying to get more for their product development dollar, rather than spending more dollars for product development. "The aim," said an AMA spokesman "is more results for the money rather than more money for results.

"Most companies don't know the actual cost of developing their new products—a cost which is a basic factor in making the most important decisions managers must make—decisions about the future," he added. "This ignorance leads to waste."

Although the trend for product development tends to be higher, alert corporations are seeking to eliminate wasteful management methods in development operations. "While the life blood of many industries continues to be new product development, there is no magic in research or in developing new or improved products if the process wastes money," he said. "One of the greatest wastes of time, money, and manpower today shows up in development programs because most corporations aren't organized structurally to absorb and put to use new knowledge and new products as rapidly as they are created.

"Mounting costs are rapidly rubbing off the glamor once associated with research and new products," he added. "If there is any single starting point in planning for growth, its focus lies in better management of technology—in turning ideas into dollars."

Competition from tax-supported technology and the tendency of antitrust and patent policies to undermine the entrenched position of existing proprietary products should spur a drive to introduce money-saving management methods already adopted by a few companies, he said.

The survey results follow:

Industry Group	Companies Reporting	1960 Budget Per Cent of 1959 Budget: Up	Same	Down	1959 Budget Average	1959 Budget Per Cent of 1959 Sales
Aircraft	9	4	2	3	4.0	2.9
Chemicals	62	48	11	3	11.4	4.0
Construction Machinery	4	2	1	1	−1.6	4.4
Electrical Machinery	11	7	4		10.1	2.7
Electronics	46	31	15		16.8	7.7
Engines and Turbines	3	2	1		11.0	1.8
Fabricated-Metal Products	23	9	9	5	1.1	2.4
Food and Beverages	19	14	5		13.1	1.7
Instruments and Control Equipment	40	29	10	1	14.0	6.1
Metalworking Machinery	6	4	2		9.3	2.3
Mining, Minerals, and Coal	5		2	3	−11.8	2.4
Misc. Machinery and Parts	7	6	1		22.0	3.6
Misc. Manufacturing	5	4	1		9.8	3.2
Nonferrous Metals	7	3	3	1	7.4	2.1
Office Machinery	10	8		2	11.3	4.2
Paper and Paper Products	11	8	2	1	9.6	1.2
Petroleum Refining	13	11	2		8.3	1.0
Pharmaceuticals	12	10	1	1	11.0	5.7
Plastics and Molded Products	5	4	1		14.6	1.6
Printing and Publishing	4	2	1	1	−5.2	2.1
Public Utilities	3	1	1	1	14.3	0.2
Rubber and Rubber Goods	9	5	3	1	10.8	2.3
Steel	7	4	3		5.7	1.6
Stone, Clay, and Glass	9	6	3		19.2	2.3
Textiles	6	6			8.3	2.1
Transportation Equipment	3	1	2		2.7	1.1
Other	63	36	23	4	10.3	3.0
Totals	402	265	109	28	Avg. 10.7%	Avg. 37%

United Engineering Center

ASME's UEC Fund Campaign Still Bogged Down

ANOTHER engineering society, ASCE, has exceeded its quota in the fund-raising drive in support of the United Engineering Center. ASME still lags nearly $100,000 short of its quota.

In recent weeks, construction on the Center has proceeded rapidly. Steel and stone have already begun to enclose the lower floors, and work on internal facilities is proceeding. During the latest 30-day period, for which figures are available, only 23 Sections of ASME reported any progress in their fund-raising efforts; the remaining 73 reported no progress for the month.

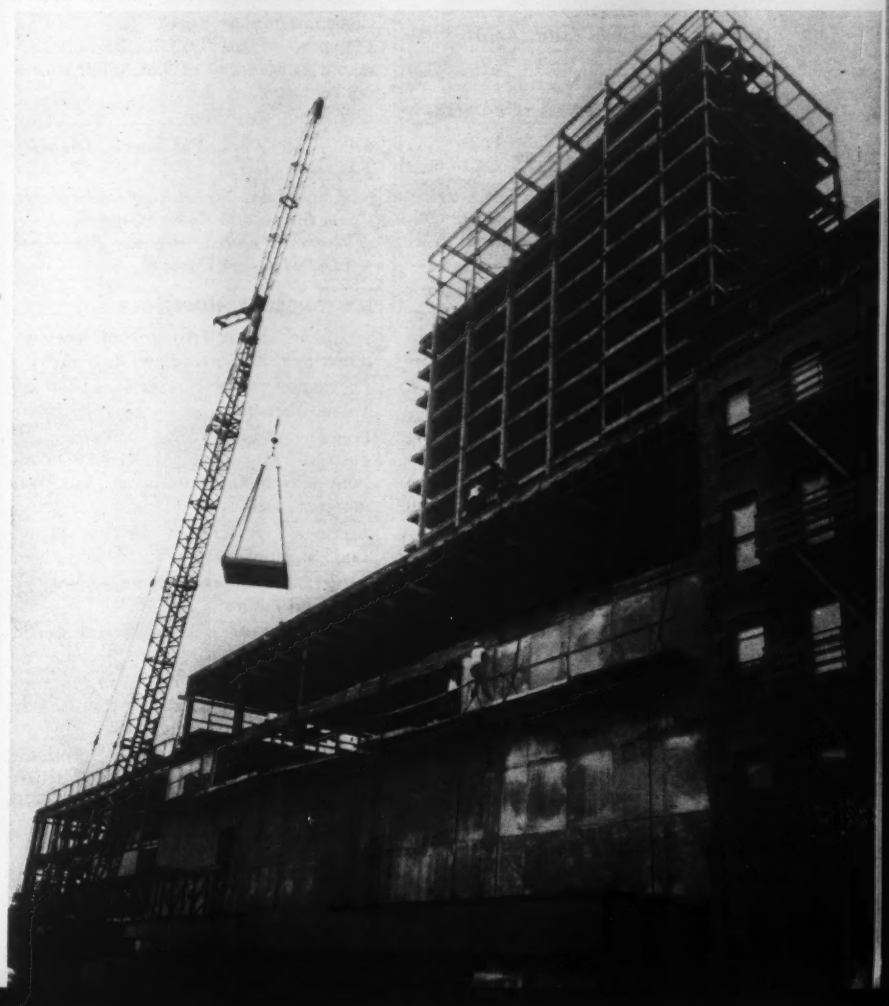
These are the elements of a continuing contrast between progress toward the United Engineering Center and ASME's slow fulfillment of its obligation.

A glance at the list of Sections and where they stand, ranged in order of dollars yet to be obtained, will tell you where your Section stands. Why not call *your* Section officers and offer *your* help to put *your* section over the top?

Per Cent of Quota	Section	◀ Your Section's Score as of Sept. 1, 1960
180.8	Waterbury	
164.0	Cincinnati	
149.6	Canton-Alliance-Massillon	
143.8	Dayton	
143.0	Northwest Florida	
136.0	Hudson-Mohawk	
130.6	West Virginia	
130.0	Youngstown	
128.0	Worcester	
124.1	Atlanta	
116.0	Detroit	
115.9	Hawaii	
112.8	Providence	
112.0	Columbia Basin	
111.5	Metropolitan (includes North Jersey and Long Island Sections)	
111.1	Birmingham	
105.9	Westmoreland	
105.1	Olean	
105.0	Central Indiana	
104.7	Central Iowa	
102.4	Southern Tier	
102.3	San Diego	
100.0	Fort Wayne	
99.1	Inland Empire	9
97.8	Erie	97
91.1	Sabine	208
90.2	North Alabama-Mississippi	230
87.0	Rock River Valley	514

		Dollars Short of Quota ▼
	SHORT OF QUOTA	
83.1	Iowa-Illinois	655
95.5	Cleveland	735
67.2	New London	747
84.0	Piedmont-Carolina	760
59.1	Gulf Coast	762
71.0	Nebraska	848
78.0	Mid-Hudson	853
93.6	Milwaukee	899
90.3	Fairfield County	910
27.6	Paducah	970
53.6	Utah	985
85.2	Rochester	1,007
66.4	Central Savannah River Area	1,023
39.6	Miami	1,051
8.3	Palm Beach	1,100
55.2	Central Michigan	1,119
42.4	Greenville	1,232
70.9	Susquehanna	1,233
85.9	Anthracite-Lehigh Valley	1,246
42.5	Central Kansas	1,264
85.4	Minnesota	1,300
29.6	Savannah	1,324
40.4	Mexico	1,336
32.5	Mohawk Valley	1,403
82.2	Columbus	1,405
57.1	Eastern Virginia	1,408
40.0	Idaho-Montana	1,452
67.0	Toledo	1,504
83.9	Kansas City	1,574
0.9	North East Florida	1,585
64.1	Syracuse	1,715
43.4	Oregon	1,790
55.4	New Haven	1,848
	MORE THAN $2000	
52.8	Arizona	2,049
71.0	Akron	2,061
79.7	Delaware	2,093
62.4	East Tennessee	2,108
22.1	Central Pennsylvania	2,150
91.1	Pittsburgh	2,172
50.5	Western Massachusetts	2,336
24.8	Eastern North Carolina	2,360
56.8	Central Illinois	2,557
15.6	Central Virginia	2,719
23.6	Virginia	2,951
18.3	St. Joseph Valley	3,054
23.7	Louisville	3,127
31.2	Florida	3,274
41.4	New Mexico	3,607
58.5	Western Washington	4,007
15.7	Northern New England	4,250
17.6	Chattanooga	4,584
62.5	Baltimore	4,996
	MORE THAN $5000	
30.5	Rocky Mountain	5,004
34.6	Buffalo	5,115
51.5	St. Louis	5,457
24.0	New Orleans	6,309
34.2	Ontario	6,901
33.5	Mid-Continent	7,027
37.1	Hartford	7,529
53.2	Mid-Jersey	7,828
40.2	South Texas	9,115
24.7	North Texas	9,407
34.6	Washington, D. C.	9,625
59.7	Boston	11,986
69.6	Chicago	13,139
43.4	San Francisco	17,482
54.8	Philadelphia	19,493
29.2	Los Angeles	36,197

This picture shows the condition of the United Engineering Center on Aug. 19, 1960. Some exterior steel and stone are already in place, and work continues on the interior equipment. The construction work is still on schedule.



Notes on Society Activities and Events

E. S. NEWMAN
News Editor

THE ASME NEWS

High Lights of 1960 ASME Winter Annual Meeting

▶SUNDAY, NOVEMBER 27

4:00 p.m. "Early Bird" Party

7:00 p.m. Joint Conference of Council, Boards, and Committees

▶MONDAY, NOVEMBER 28

12:15 p.m. President's Luncheon

Presentation of:

Melville Medal to *William Godfrey Steltz*

Junior Award to *Gunnar Heskestad* and *Duane Robert Olberts*

Address: *Walker L. Cisler*, ASME President

4:45 p.m. Business Meeting

8:00 p.m. Japanese Variety Program

▶TUESDAY, NOVEMBER 29

12:15 p.m. Fuels Luncheon

Presider: *William T. Reid*, assistant technical director, Battelle Memorial Institute, Columbus, Ohio

Speaker: *James H. Harlow*, chief mechanical engineer, Philadelphia Electric Company, Philadelphia, Pa.

Subject: **Heat Rate Isn't Everything**

12:15 p.m. Heat Transfer Luncheon

Presider: *Harold A. Johnson*, professor, department of mechanical engineering, University of California, Berkeley

Speaker: *Myron Tribus*, professor, engineering department, University of California, Los Angeles

Subject: *Convection—From Newton to Now*

12:15 p.m. Machine Design Luncheon

Presider: *J. W. Huckert*, associate editor, *Machine Design*, Penton Publishing Company, Cleveland, Ohio

Presentation of:

Machine Design Medal to *Rudolph Earl Peterson*

Blackall Machine Tool and Gage Award to *B. Popper* and *David Wolfgang Pessen*

Speaker: *R. E. Peterson*, manager of mechanics department, Westinghouse Research Laboratories, Pittsburgh, Pa.

Subject: **The Role of Applied Mechanics in Machine Design**

12:15 p.m. Professional Practice Committee Luncheon

Presider: *Daniel T. Webster*, general manager, Guy B. Panero Engineers, New York, N. Y.

1:00 p.m. Plant Trip to Indian Point Power Plant of Consolidated Edison Company of New York

1:30 p.m. Plant Trip to Bayonne Research Laboratory of The International Nickel Company, Inc.

4:00 p.m. Tea Dance

6:00 p.m. Applied Mechanics Dinner

Presentation of:

Timoshenko Medal to *Cornelis Benjamin Biezeno* and *Richard Grammel*

Worcester Reed Warner Medal to *Lloyd Hamilton Donnell*

▶WEDNESDAY, NOVEMBER 30

9:00 a.m. Plant Trip to New York International Airport, Idlewild, N. Y.

12:15 p.m. Management Luncheon and Towne Lecture

Presider: *Hugh A. Bogle*, supervisor, Industrial Engineering Activity, E. I. du Pont de Nemours & Company, Inc., Wilmington, Del.

Lecturer: *L. Urwick*, Urwick House, London, England

Subject: **Engineers in Management—Past and Future**

12:15 p.m. Metals Engineering Luncheon

Presider: *William E. Cooper*, General Electric Company, Knolls Atomic Power Laboratory, Schenectady, N. Y.

Speaker: *Thomas J. Dolan*, professor, theoretical and applied mechanics department, University of Illinois, Urbana, Ill.

1:00 p.m. Plant Trip to Model C Stellarator Laboratory at Princeton University

6:00 p.m. Hydraulic Dinner

Toastmaster: *Howard W. Emmons*, professor of mechanical engineering, Harvard University, Cambridge, Mass.

Speaker: *Arthur Kantrowitz*, vice-president, AVCO Corp.; director, AVCO-Everett Research Laboratory

Subject: **The Research Frontier in Fluid Mechanics**

▶THURSDAY, DECEMBER 1

9:00 a.m. Plant Trip to Grumman Aircraft Engineering Corporation, Bethpage, N. Y.

12:15 p.m. Members and Students Luncheon

Presentation of:

Arthur L. Williston Medal and Award to *Marc Fishzohn*

Pi Tau Sigma Gold Medal Award to *George N. Hatsopoulos*

Richards Memorial Award to *Ascher H. Shapiro*

Charles T. Main Award to *John W. McDaniel*

Undergraduate Student Award to *Theodore C. Kuchlen, Jr.*

Official Notice

ASME Business Meeting

THE Annual Business Meeting of the members of The American Society of Mechanical Engineers will be held on Monday afternoon, Nov. 28, 1960, at 4:45 p.m., at the Statler Hilton Hotel, New York, N. Y., as part of the Winter Annual Meeting of the Society.

Members are urged to attend.

Old Guard Prize to *Joseph W. Lindsey*
Old Guard Prize Paper: **A Cold Flow Study of Nozzle Feeding in a Four-Nozzle Rocket Case,** by *Joseph W. Lindsey*, University of Utah, Salt Lake City, Utah
6:00 p.m. Social Hour
7:00 p.m. Banquet

Invocation: *Carl J. Eckhardt*, Fellow ASME

Presentation of ASME Medal to *Carl Richard Soderberg*

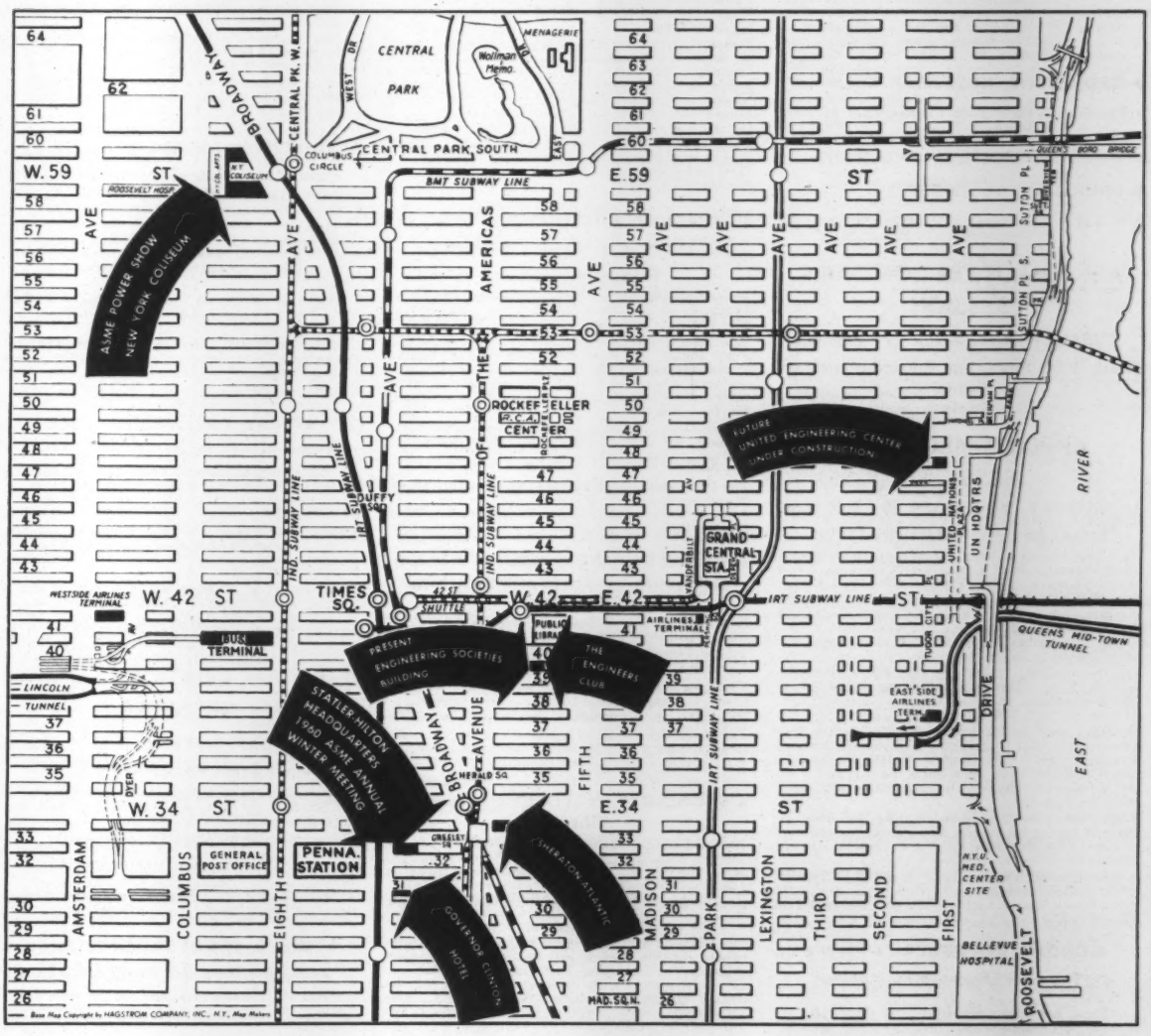
Conferral of Honorary Membership on *Henry Townley Heald*

Speaker: *Canon Laurence H. Hall*, Rector of St. Paul's Episcopal Church, East Cleveland, Ohio

Subject: **Humor, a Catalyst to Creative Thinking**

10:00 p.m. Dance

Deep in the heart of Manhattan. The map highlights the important spots so that visitors may get around town easily—if there are no taxis available, check your map, there is a subway—The New York Coliseum where the Power Show will be held is five minutes by subway from the Statler Hilton Hotel where the Winter Annual Meeting will be held. The Engineers' Club and the present Engineering building are within walking distance, if you are meeting friends at the Club or planning to use the Engineering Societies Library. The Library should be high on everyone's list of "Places to Visit." Over toward the East River and diagonally across from the United Nations is the rapidly nearing completion United Engineering Center. With the Meeting held so close to Christmas, the women will be delighted to know that they are an "island" surrounded by shopping spots . . .everything from the largest department stores in the world to the most elegant specialty stores are accessible quickly and in some instances without even going outdoors. Just a stone's throw from fabulous Fifth Avenue where one can shop from the Five-and-Ten to Tiffany's, it takes a few minutes more to go down to the "Village" to find those quaint pieces of jewelry, an odd painting, or to dine at some of the finest restaurants in the city. Back to the map again, we shall all be too busy to wander very far. Broadway is prosaically indicated by a subway line—but try it some evening. Stroll up a way. The Met stands—but not for long—at 39th Street; keep going north and just beyond 42nd Street The Great White Way really lights up. East and west of "The Stem" in the Forties is New York's rialto . . .heart of a great theatrical world. By Meeting time the season will have been off to a good start and everything from a brilliant, flashy, impossible-to-get-tickets-for revue to the most distinguished drama will be available for an evening's entertainment merely for the choosing. On Wednesday, November 30, you can see Mary Martin in "Sound of Music," if you send your check, made payable to ASME, to Mrs. J. J. Moro-Lin, 22 Beverly Road, Glen Rock, N. J. Orchestra seats are $10.50; balcony seats, $8.25. Now look at the map again, at 50th Street and Eighth Avenue is The Garden—that's where you go to see the fights, ice hockey, basketball—it is truly a sportsman's paradise. Nightlife—the variety is as limitless as the tastes it caters to—East Side or West Side, all around the town. Here's the map, don't get lost.



Registration Schedule

Sunday, November 27, 2:00 p.m. to 5:00 p.m.
Monday, November 28, 8:00 a.m. to 5:00 p.m.
Tuesday, November 29, 8:00 a.m. to 8:00 p.m.
Wednesday, November 30, 8:00 a.m. to 8:00 p.m.
Thursday, December 1, 8:00 a.m. to 3:00 p.m.
Friday, December 2, 8:00 a.m. to 12 noon

COLLEGE REUNIONS

INFORMATION about time and place may be obtained at the Registration Headquarters at the Statler Hilton Hotel during the meeting.

PLANT TRIPS

▶TUESDAY, NOVEMBER 29

1:00 p.m. Indian Point Power Plant of Consolidated Edison Company of New York
1:30 p.m. Bayonne Research Laboratory of The International Nickel Company, Inc.

▶WEDNESDAY, NOVEMBER 30

9:00 a.m. New York International Airport, Idlewild, N. Y.
1:00 p.m. Model C Stellarator Laboratory at Princeton University

▶THURSDAY, DECEMBER 1

9:00 a.m. Grumman Aircraft Engineering Corporation, Bethpage, N. Y.

AIR-POLLUTION CONTROLS SESSION

TUESDAY, NOVEMBER 29 2:30 p.m.

Jointly With Fuels, and Corrosion and Deposits

See Fuels 4

APPLIED MECHANICS SESSIONS

1 MONDAY, NOVEMBER 28 9:30 a.m.

Stress Analysis—Elasticity-Plates

An Exploratory Study of Three-Dimensional Photothermoelasticity, by *Herbert Tramposch* and *George Gerard*, New York Univ. (Paper No. 60—WA-49)

A Nondestructive Three-Dimensional Strain Analysis Method, by *A. J. Durelli* and *I. M. Daniel*, Armour Res. Foundation (Paper No. 60—WA-16)

On the Bending, Buckling, and Flexural Vibration of Simply Supported Polygonal Plates by Point Matching, by *H. D. Conway*, Cornell Univ. (Paper No. 60—WA-38)

Stresses and Deflections in an Elastically Restrained Circular Plate Under Hydrostatic Normal Pressure Over a Segment,[2] by *W. A. Bassali*, Univ. of Alexandria, Alexandria, Egypt, and *N. O. M. Hanna*, Ein Shams Univ., Cairo, Egypt (Paper No. 60—WA-30)

Experiments on the Postbuckling Behavior of Square Plates Loaded in Edge Compression,[2] by *Noboro Yamaki*, Tohoku Univ., Sendai, Japan (Paper No. 60—WA-103)

A New Approach to the Analysis of the Deflection of Thin Cantilevers,[2] by *R. Frisch-Fay*, Univ. of New South Wales, Sydney, Australia (Paper No. 60—WA-17)

2 MONDAY, NOVEMBER 28 2:30 p.m.

Thermal Stress—Kinematics

Transient Thermal Stresses in a Circular Cylinder, by *C. K. Youngdahl* and *Eli Sternberg*, Brown Univ. (Paper No. 60—WA-123)

On Transient Thermal Stresses in Viscoelastic Materials With Temperature Dependent Properties, by *Rokuro Muki* and *Eli Sternberg*, Brown Univ. (Paper No. 60—WA-124)

On the Burmester Points of a Plane, by *F. Freudenstein*, Columbia Univ., and *G. N. Sandor*, Time, Inc. (Paper No. 60—WA-125)

3 TUESDAY, NOVEMBER 29 9:30 a.m.

Shells

On the Buckling of Circular Cylindrical Shells Under Pure Bending, by *Paul Seide* and *V. I. Weingarten*, Space Technology Labs., Inc. (Paper No. 60—WA-33)

Stress Distribution in a Rotating Spherical Shell of Arbitrary Thickness, by *M. A. Goldberg*, Grumman Aircraft Engrg. Corp., *V. L. Salerno*, Fairleigh Dickinson Univ., Grumman Aircraft Engrg. Corp., and *M. A. Sadowsky*, Rensselaer Polytechnic Inst. (Paper No. 60—WA-19)

On the Bending of Circular Cylindrical Shells by Equal and Equally Spaced End Radial Shear Forces and Moments,[2] by *Paul Seide* and *V. I. Weingarten*, Space Technology Labs., Inc. (Paper No. 60—WA-32)

4 TUESDAY, NOVEMBER 29 2:30 p.m.

Jointly With Metals Engineering

Plasticity—Fracture

A Modification of the Coulomb-Mohr Theory of Fracture, by *B. Paul*, Brown Univ. (Paper No. 60—WA-31)

The Effect of Shear and Normal Forces on the Fully Plastic Moment of Beams of Rectangular Cross Section, by *B. G. Neal*, Univ. College of Swansea, Swansea, Great Britain. (To be presented by *P. S. Symonds*, Brown Univ.) (Paper No. 60—WA-102)

Experimental Investigation of Corners in the Yield Surface, by *Aris Phillips*, Yale Univ., and *G. A. Gray*, Virginia Polytechnic Inst. (Paper No. 60—WA-7)

The Penetration of Hard Steel Spheres Into Plane Metal Surfaces,[2] by *Werner Goldsmith* and *P. T. Lyman*, Univ. of California (Paper No. 60—WA-15)

5 WEDNESDAY, NOVEMBER 30 9:30 a.m.

Colloquium on Shock and Structural Response

Shock Loading and Response Spectra,[4] by *Y. C. Fung*, California Inst. of Tech.

Measurement of Shock Motions,[4] by *Irwin Vigness*, U. S. Naval Res. Lab.

Concepts in Shock Testing of Equipment,[4] by *C. E. Crede*, California Inst. of Tech.

Response of Continuous Systems,[4] by *Dana Young*, Yale Univ.

Ground Shock and Missile Response,[4] by *M. V. Barton*, Space Technology Labs., Inc.

6 WEDNESDAY, NOVEMBER 30 2:30 p.m.

Vibration

On the Stability of the Linearly Related Modes of Certain Nonlinear Two-Degree-of-Freedom Systems, by *C. P. Atkinson*, Univ. of California (Paper No. 60—WA-26)

Steady-State Behavior of Nonlinear Dynamic Vibration Absorber, by *W. J. Carter*, Univ. of Texas, and *F. C. Liu*, Boeing Airplane Co. (Paper No. 60—WA-14)

On the Response of Linear Systems to Time-Dependent Multidimensional Loadings, by *F. P. Beer*, Lehigh Univ. (Paper No. 60—WA-106)

Forced Oscillations of a Semi-Infinite Rod Exhibiting Weak Bilinear Hysteresis,[2] by *T. K. Caughey*, California Inst. of Tech. (Paper No. 60—WA-28)

7 WEDNESDAY, NOVEMBER 30 8:00 a.m.

Progress Report of Research Committee on Random Vibration

Committee Members

S. H. Crandall, M.I.T.
R. B. Dow, Air Res. & Dev. Command
E. G. Fischer, Westinghouse Res. Labs.
W. H. Hoppman, II, Rensselaer Polytechnic Inst.
D. E. Hudson, California Inst. of Tech.

8 THURSDAY, DECEMBER 1 9:30 a.m.

Vibration

Propagation of Axisymmetric Waves in an Unlimited Elastic Shell, by *A. Kalnins* and *P. M. Naghdi*, Univ. of California (Paper No. 60—WA-22)

Vibrations of Elastic Sandwich Cylindrical Shells, by *Yi-Yuan Yu*, Polytechnic Inst. of Brooklyn (Paper No. 60—WA-21)

On the Probability Densities of the Outputs of Some Random Systems, by *Frank Kozin*, Purdue Univ. (Paper No. 60—WA-18)

Random Excitation of a System With Bi-Linear Hysteresis,[2] by *T. K. Caughey*, California Inst. of Tech. (Paper No. 60—WA-27)

9 THURSDAY, DECEMBER 1 2:30 p.m.

Fluid Mechanics—Thermodynamics

An Improved Integral Procedure for Compressible Laminar Boundary-Layer Analysis, by *Kwang-tsu Yang*, Univ. of Notre Dame (Paper 60—WA-24)

Heat Transfer and Sublimation at a Stagnation Point in Potential Flow, by *W. W. Short*, Convair, Div. of Gen. Dynamics Corp. (Paper No. 60—WA-20)

Torque and Cavitation Characteristics of Butterfly Valves, by *Turgut Sarpkaya*, Univ. of Nebraska (Paper No. 60—WA-105)

Information Theory as the Basis for Thermostatics and Thermodynamics—Part 1, by *Myron Tribus*, Univ. of California (Paper No. 60—WA-23)

10 FRIDAY, DECEMBER 2 9:30 a.m.

Lubrication—Bearings—Heat Flow

On the Compressibility Effects of the Lubricant for Two-Dimensional Slider Bearings, by *K. T. Yen*, Rensselaer Polytechnic Inst. (Paper No. 60—WA-29)

Adiabatic Analysis of Elastic, Centrally Pivoted, Sector, Thrust Bearing Pads, by *B. Sternlicht, G. K. Carter*, and *E. B. Arwas*, Gen. Elec. Co. (Paper No. 60—WA-104)

Transient Heat Conduction in a Rod of Finite Length With Variable Thermal Properties, by *Wen-Hwa Chu* and *H. Norman Abramson*, Southwest Res. Inst. (Paper No. 60—WA-25)

AVIATION SESSIONS

1-A MONDAY, NOVEMBER 28 9:30 a.m.

Rocket Power—Part 1

Electrical Propulsion Application and System Requirements,[1] by *C. J. McDole*, Rocketdyne, Div. of North American Aviation, Inc.

The Application of the Pinch Process for Space Propulsion, by *Irving Granet* and *W. J. Guman*, Republic Aviation Corp. (Paper No. 60—WA-254)

A Method of Rocket Engine Parameter Evaluation,[1] by *Bruce Neuffer*, Gen. Elec. Co.

1-B MONDAY, NOVEMBER 28 9:30 a.m.

Applied Loads and Proof of Design

Special Pilot Considerations for Sweptwing Jet Transports,[1] by *W. R. Haldeman*, Federal Aviation Agency

[1] Paper not available—see box on page 116.
[2] Not presented orally.

[2] Not to be printed.
[4] A bound volume consisting of all papers presented at this session will be available for purchase at the Technical Papers Desk and Publications Display Booth on the Mezzanine of the Statler Hilton Hotel during the meeting. These papers will not be published as separate papers nor will they be published in any other form.

Hydrofoil Boat Hull-Wave Impact Loads,[1] by *W. R. Jensen*, Grumman Aircraft Engrg. Corp.

A Method of Predicting the Lateral Frequencies of Vibration of Helical Extension Springs,[1] by *J. C. Dunn*, Grumman Aircraft Engrg. Corp.

1-C MONDAY, NOVEMBER 28 9:30 a.m.

Air Force Material Handling

The Air Force Material-Handling Support-System Concept,[1] by *M. E. Peterson*, USAF Advanced Supporting Systems Office

The Air Force Aircraft-Cargo Loading System,[1] by *S. A. LaMar*, Douglas Aircraft Co., Inc.

Air Force Terminal Design and Operations,[1] by *W. A. Sawyer*, Arthur D. Little, Inc.

2-A MONDAY, NOVEMBER 28 2:30 p.m.

Rocket Power—Part 2

Numerical Determination of the Dynamic Influence Coefficients of a Single-Barrel Rocket Engine System, When Mounted on a Vertical Test Stand,[1] by *W. B. Small*, Rocketdyne, Div. of North America Aviation, Inc.

Increased Shell Strengths Through Wire-Wrap and Plastic-Wrap Techniques,[1] by *R. E. Young*, Hercules Powder Co.

Tactical and Operational Advantages Attainable by Superperformance Aircraft Rocket Engines,[1] by *C. R. Bell*, Rocketdyne, Div. of North American Aviation, Inc.

2-B MONDAY, NOVEMBER 28 2:30 p.m.

Automatic Ground Checkout Equipment

Current Operating Experience of Missile Ground Checkout Equipment,[1] by *C. H. Barr*, Navy Dept.

System-Test Techniques for Mach 3 Aircraft,[1] by *A. C. Fulkerson* and *M. Pollack*, North American Aviation, Inc.

Automated Maintenance and Airline Economy for Supersonic Aircraft,[1] by *E. R. Woods* and *C. L. Blake*, Convair

An Airline's Interest in Automatic Ground Checkout Equipment,[1] by *William Littlewood*, American Air Lines, Inc.

3 TUESDAY, NOVEMBER 29 9:30 a.m.

Ground-Based Radar Antenna Design

Bearing Concepts for Supporting Large Antennas,[1] by *J. A. Ziemianski*, Goodyear Aircraft Corp.

A Servo System for a Large Radar Antenna Utilizing High-HP Eddy-Current Clutches,[1] by *D. L. Brown* and *W. L. Hinks*, Goodyear Aircraft Corp.

TUESDAY, NOVEMBER 29 9:30 a.m.

Jointly With Gas Turbine Power and Hydraulic

See Gas Turbine Power 1

4 TUESDAY, NOVEMBER 29 2:30 p.m.

The Heavy Presses Stage a Comeback

The Heavy Presses—Gateway to Space,[1] by *R. L. Albrecht*, USAF Air Material Command

Heavy Presses in the Space Age,[1] by *L. W. Mayer*, Aluminum Co. of America

Forgings for Missiles and Space Vehicles,[1] by *W. C. Kunkler* and *J. R. Canal*, Wyman-Gordon Co.

TUESDAY, NOVEMBER 29 2:30 p.m.

Jointly With Gas Turbine Power and Hydraulic

See Gas Turbine Power 2

5 TUESDAY, NOVEMBER 29 8:00 p.m.

Jointly With Instruments and Regulators

Control of Gas Turbine Engines

Practical Aspects of Small Gas-Turbine-Engine Controls,[1] by *A. A. Stefucsa*, The Bendix Corp.

Turboprop Engine Controls,[1] by *F. J. Boyer* and *R. J. Wente*, Gen. Motors Corp.

Jet-Engine-Control Problems in Large High-Speed Aircraft,[1] by *W. Schaeffer*, Gen. Elec. Co.

TUESDAY, NOVEMBER 29 8:00 p.m.

Jointly With Gas Turbine Power and Hydraulic

See Gas Turbine Power 3

6-A WEDNESDAY, NOV. 30 9:30 a.m.

Jointly With Gas Turbine Power

Novel Power-Plant Applications

Turboshaft Power for Marine Propulsion,[1] by *G. A. Hardgrove*, Gen. Elec. Co.

The MU-CYL-JET (The Multicylinder Turbojet Engine), by *R. W. Pinnes*, Bureau of Naval Weapons (Paper No. 60—WA-84)

Design and Test of a Tip-Turbine Driven Lift Fan for VTOL Aircraft,[1] by *A. P. Adamson*, Gen. Elec. Co. (Paper No. 60—WA-224)

6-B WEDNESDAY, NOV. 30 9:30 a.m.

Jointly With Instrument and Regulators

Measurement Techniques for Precision Instruments

Use of a Centrifuge for the Precision Measurement of Accelerometer Characteristics, by *S. R. Sporn*, American Bosch Arma Corp. (Paper No. 60—WA-195)

Performance of Gyroscopes and Accelerometers in a Vibration Environment, by *W. E. Fellows*, Minneapolis-Honeywell Regulator Co. (Paper No. 60—WA-246)

Gyro Micro-Yield Measurements on a Precision Linear Vibrator, by *P. J. Palmer*, M.I.T. Instrumentation Lab. (Paper No. 60—WA-247)

7 WEDNESDAY, NOV. 30 2:30 p.m.

Ultra-High Pressure Developments

Equipment Developments,[1] by *Alexander Zeillin*, Engrg. Supervision Co.

Calibration Techniques in Ultra-High Pressure Apparatus, by *F. P. Bundy*, Gen. Elec. Co. (Paper No. 60—WA-178)

Ultra-High Pressure Physics,[1] by *W. G. Field*, Air Force Cambridge Res. Labs.

Metallurgical Developments in Ultra-High Pressure Research,[1] by *J. E. Hilliard*, Gen. Elec. Res. Lab.

WEDNESDAY, NOVEMBER 30 2:30 p.m.

Jointly With Gas Turbine Power

See Gas Turbine Power 4

BOILER FEEDWATER STUDIES SESSIONS

1 FRIDAY, DECEMBER 2 9:30 a.m.

Jointly With Power

Evaluation of Steam Washers in Power-Plant Boilers, by *H. A. Klein*, Combustion Engrg., Inc. (Paper No. 60—WA-213)

Vacuum Deaerator Design, by *A. W. Kingsbury* and *E. L. Phillips*, The Permutit Co., Div. of Pfaudler Permutit Inc. (Paper No. 60—WA-214)

The Relation Between Boiler Cleanliness and Feedwater, by *F. U. Neat*, Baltimore Gas & Elec. Co. (Paper No. 60—WA-216)

Performance of Stainless - Steel Condenser Tubes, by *R. H. Pell*, Monongahela Power Co. (Paper No. 60—WA-217)

2 FRIDAY, DECEMBER 2 2:30 p.m.

Jointly With Power

German Developments in the Field of Acid Pickling of High-Pressure Boilers, by *H. G. Heitmann*, Siemens-Schuckertwerke A.G., Erlangen, Germany (Paper No. 60—WA-227)

New Chemical Cleaning Concepts and Possible Applications for the Future, by *C. M. Loucks*, consulting chemist, Westlake, Ohio (Paper No. 60—WA-259)

Chemical Cleaning of Pre-Boiler Equipment, by *W. B. Willsey*, Philadelphia Elec. Co. (Paper No. 60—WA-262)

Chemical Cleaning of Controlled Circulation Boilers, by *H. J. Vyhnalek*, Cleveland Elec. Illuminating Co. (Paper No. 60—WA-258)

Acid Cleaning of Superheaters and Reheaters, by *S. M. Rose* and *W. F. Ashton*, Sumco Engrg., Inc. (Paper No. 60—WA-219)

Chemical Cleaning With Citric Acid Solutions, by *W. E. Bell*, Chas. Pfizer & Co., Inc. (Paper No. 60—WA-257)

Precautions in the Use of Citric Acid, by *E. B. Morris*, American Elec. Power Service Corp. (Paper No. 60—WA-221)

CORROSION AND DEPOSITS SESSIONS

TUESDAY, DECEMBER 29 2:30 p.m.

Jointly With Fuels and Air Pollution Controls

See Fuels 4

1 THURSDAY, DECEMBER 1 9:30 a.m.

Jointly With Fuels

A Study of Sulfur Reactions in Furnace Deposits, by *Murray Weintraub*, *S. A. Goldberg*, and *A. A. Orning*, U. S. Bureau of Mines (Paper No. 60—WA-183)

Corrosion of Superheaters and Reheaters of Pulverized-Coal-Fired Boilers, Part 2, by *Carl Cain, Jr.*, and *Wharton Nelson*, Combustion Engrg., Inc. (Paper No. 60—WA-180)

Chemical Thermodynamics of Corrosion Products—Part 1: **Equilibrium Concentrations of Minor Constituents of Combustion Gas.** Part 2: **The Stabilities of Iron and Sodium Compounds in Fireside Deposits,** by *R. H. Boll* and *H. C. Patel*, The Babcock & Wilcox Co. (Paper No. 60—WA-182)

2 THURSDAY, DECEMBER 1 2:30 p.m.

Jointly With Fuels

Reactions of Magnesium With Inorganic Constituents of Heavy Fuel Oil and Characteristics of Compounds Formed,[1] by *W. D. Niles* and *H. R. Sanders*, Esso Res. & Engrg. Co.

Slurry Spraying of Additives for the Control of Corrosion and Deposits in Oil-Fired Boilers,[1] by *W. F. Cantieri* and *R. E. Chappell*, Diamond Power Specialty Corp., and *R. A. Baker*, Public Service Elec. & Gas Co.

Effect of Ammonia Injection on Corrosion in Air Preheaters, by *Bernard Paris* and *Roy Kato*, Foster Wheeler Corp. (Paper No. 60—WA-255)

New Developments in Handling the Fuel-Oil Ash-Corrosion Problem, by *D. W. McDowell, Jr.*, and *J. R. Mihalisin*, International Nickel Co., Inc. (Paper No. 60—WA-260)

FLUID METERS SESSION

MONDAY, NOVEMBER 28 2:30 p.m.

Expansion Coefficients for Orifice Meters in Pipes Less Than One Inch in Diameter, by *G. A. Marxman*, California Inst. of Tech., and *Henry Burlage, Jr.*, Case Inst. of Tech. (Paper No. 60—WA-137)

Gas-Tracer Method of Steady and Pulsating Flow Measurement, by *J. F. Kemp*, South African Council for Scientific & Industrial Research, Pretoria, Union of South Africa. (To be presented by *E. J. Lindahl*, Univ. of Wyoming.) (Paper No. 60—WA-142)

Flow Measurement for Accounting Purposes, by *D. D. Livingstone*, Polymer Corp. Ltd., Sarnia, Ont., Canada (Paper No. 60—WA-141)

FUELS SESSIONS

1 MONDAY, NOVEMBER 28 9:30 a.m.

Special Fuel Applications

Coking Stokers,[1] by *Walter Giesing*, Central Fibre Products, and *John Cruise*, consultant

Fuels in the Cement Industry,[1] by *F. B. Tripp*, Portland Cement Assoc.

Tangential Firing of Regenerator-Waste Gas in CO Boilers,[1] by *Joseph Singer* and *S. Blackburn*, Combustion Engrg., Inc.

2 MONDAY, NOVEMBER 28 2:30 p.m.

Jointly With Power

Panel Discussion: Furnace Safeguards

[1] Paper not available—see box on page 116.
[2] Not to be printed.

Orders for ASME Technical Papers

ONLY numbered ASME papers in this program are available in separate copy form until Oct. 1, 1961. Prices are 50 cents to members of ASME, $1 to nonmembers, plus postage and handling charges. Payment also may be made by free coupons, or coupons which may be purchased from the Society in lots of ten at $4 to members; $8 to nonmembers. You can save the postage and handling charges by including your check or money order made payable to ASME with your order and sending both to: ASME Order Department, 29 West 39th Street, New York 18, N. Y. Papers must be ordered by the paper numbers listed in this program, otherwise the order will be returned. The issue of MECHANICAL ENGINEERING containing an account of the Winter Annual Meeting also will carry a complete listing of all available papers.

Note: All numbered papers in this program will be available two weeks before the opening date of the meeting. Hence some mail orders may be delayed for this reason.

3 TUESDAY, NOVEMBER 29 9:30 a.m.

Experiments on an MHD Fuel-Burning Generator,[1] by *W. E. Young*, Westinghouse Res. Labs.

Studies of Heat Absorption With Pulverized-Coal Firing,[1] speaker to be announced.

4 TUESDAY, NOVEMBER 29 2:30 p.m.

Jointly With Corrosion and Deposits, and Air-Pollution Controls

The Measured Effects of Some Operating Conditions on Fouling Tendencies of Low-Temperature Boiler-Flue Gases,[1] by *A. W. Black*, Air Preheater Corp.

Effects of Combustion Conditions on Nitrogen, Oxide Formation in Boiler Furnaces,[1] by *J. D. Sensenbaugh* and *J. Jonakin*, Combustion Engrg., Inc.

THURSDAY, DECEMBER 1 9:30 p.m.

Jointly With Corrosion and Deposits

See Corrosion and Deposits 1

THURSDAY, DECEMBER 1 2:30 p.m.

Jointly With Corrosion and Deposits

See Corrosion and Deposits 2

GAS TURBINE POWER SESSIONS

1 TUESDAY, NOVEMBER 29 9:30 a.m.

Jointly With Hydraulic and Aviation

Résumé of Transonic Compressor Research at NASA Lewis Laboratory, by *Seymour Lieblein* and *I. A. Johnsen*, NASA, Lewis Res. Center (Paper No. 60—WA-97)

The General Electric Transonic Cascade Tunnel,[1] by *B. K. Genetti* and *J. R. Erwin*, Gen. Elec. Co.

[1] Paper not available—see box on this page.

Shock Losses in Transonic Compressor-Blade Rows, by *Genevieve R. Miller, G. W. Lewis, Jr.*, and *M. J. Hartmann*, NASA, Lewis Res. Center (Paper No. 60—WA-77)

2 TUESDAY, NOVEMBER 29 2:30 p.m.

Jointly With Hydraulic and Aviation

A Reappraisal of Supersonic Compressors,[1] by *J. F. Klapproth*, Gen. Elec. Co.

Critical High Lights in the Development of Transonic Compressors,[1] by *R. O. Bullock*, AiResearch Mfg. Co. of Arizona

Experiences With Compressors at High-Stage-Load Coefficient and Mean Degree of Reaction Close to Zero,[1] by *K. E. Wichert*, Fairchild Engine & Airplane Corp.

Résumé of Transonic Compressor Research at Langley Laboratory,[1] by *Melvyn Savage*, NASA, *Emanuel Boxer*, NASA, Langley Res. Center, and *J. R. Erwin*, Gen. Elec. Co.

3 TUESDAY, NOVEMBER 29 8:00 p.m.

Jointly With Hydraulic and Aviation

Aerodynamic Design and Performance of a Five-Stage, Transonic, Axial-Flow Compressor,[1] by *Karl Kovach*, Gen. Elec. Co., and *D. M. Sandercock*, NASA, Lewis Res. Center.

The J83 Seven-Stage Transonic Compressor, by *J. A. King*, AiResearch Mfg. Div. of The Garrett Corp. (Paper No. 60—WA-93)

A Practical Solution to the Three-Dimensional Flow Problem in Transonic Axial Flow Compressors, by *W. C. Swan*, Boeing Airplane Co. (Paper No. 60—WA-191)

WEDNESDAY, NOVEMBER 30 9:30 a.m.

Jointly With Aviation

See Aviation 6-A

4 WEDNESDAY, NOVEMBER 30 2:30 p.m.

Jointly With Aviation

Aerodynamic Design and Development of the General Electric CJ805-23 Aft Fan Component,[1] by *R. A. Novak* and *L. C. Wright*, Gen. Elec. Co.

Design and Development of a Transonic Compressor for General Electric's T58 Turboshaft Engine, by *M. H. Thorson*, Gen. Elec. Co. (Paper No. 60—WA-171)

Description of a Marine Auxiliary 250-kw Variable Frequency Gas-Turbine-Driven Generator Set,[1] by *D. J. Todd*, Thompson-Ramo-Wooldridge Corp., *G. R. Wagner*, Dept. of the Navy, and *Leo Cohen*, Thompson-Ramo-Wooldridge Corp.

5 WEDNESDAY, NOVEMBER 30 8:00 p.m.

A Study on Design Criteria and Matching of Turbomachines—Part A: Similarity Relations and Design Criteria of Turbines, by *O. E. Balje*, engrg. consultant, Hollywood, Calif. (Paper No. 60—WA-230)

A Study on Design Criteria and Matching of Turbomachines—Part B: Compressor and Pump Performance and Matching of Turbocomponents, by *O. E. Balje*, engrg. consultant, Hollywood, Calif. (Paper No. 60—WA-231)

Turbocompressor Drive Couplings, by *J. H. Anderson*, Borg-Warner Corp. (Paper No. 60—WA-212)

The Rotating Nozzle (HERO'S) Turbine,[1] by *J. F. Brady*, U. S. Navy Underwater Ordnance Station

THURSDAY, DECEMBER 1 9:30 a.m.

Jointly With Instruments and Regulators

See Instruments and Regulators 1

HEAT TRANSFER SESSIONS

1 MONDAY, NOVEMBER 28 2:30 p.m.

Convection

Heat Transfer to Longitudinal Laminar Flow Between Cylinders, by *E. M. Sparrow*, Univ. of Minnesota, *A. L. Loeffler, Jr.*, Grumman Aircraft Engrg. Corp., and *H. A. Hubbard*, NASA, Lewis Res. Center (Paper No. 60—WA-40)

Axial Temperature Distribution for Nuclear Reactor With Sinusoidal Space and Exponential Time Varying Power Generation, by *W. O. Doggett*, North Carolina State College, and *E. L. Arnold*, U. S. Military Academy (Paper No. 60—WA-194)

Unsteady Laminar Flow in a Duct With Unsteady Heat Addition, by *Morris Perlmutter* and *Robert Siegel*, NASA, Lewis Res. Center (Paper No. 60—WA-174)

A Variational Method for Laminar Heat Transfer in Channels, by *H. C. Agrawal*, Indian Inst. of Tech., Kharagpur, India (Paper No. 60—WA-98)

A Study of the Influence of Entry Angle in Vortex Flow-Temperature Separation, by *J. E. Lay* and *B. C. Lee*, Michigan State Univ. (Paper No. 60—WA-239)

Flow-Visualization Studies of Transition to Turbulence in Free Convection Flow, by *E. R. G. Eckert* and *J. P. Hartnett*, Univ. of Minnesota, and *T. F. Irvine, Jr.*, North Carolina State College (Paper No. 60—WA-250)

2 TUESDAY, NOVEMBER 29 9:30 a.m.

Convective Processes

Heat Transfer in Rarefied Gas Flow,[1] by *R. F. Probstein*, Brown Univ.

Problems of Heat Transfer Across Laminar Boundary Layers,[1] by *Nils Frössling*, Chalmers Univ. of Tech, Göteborg S., Sweden

A Theory of Turbulent Convection,[1] by *W. V. R. Malkus*, Woods Hole Oceanographic Inst.

Boundary-Layer Development Under Pressure Gradients, With Particular Reference to Heat Transfer,[1] by *R. J. Monaghan*, Royal Aircraft Establishment, Farnborough, Hants, England

3 TUESDAY, NOVEMBER 29 2:30 p.m.

Convective Processes, Solid State, Multiphase Processes

Turbulent Heat Transfer in Stratified Flow,[1] by *F. Schultz-Grunow*, Lehrstuhl für Mechanik, Technische Hochschule, Aachen, Germany

Transport of Thermal Energy in Solids,[1] by *J. A. Krumhansl*, Cornell Univ.

Things We Don't Know About Boiling Heat Transfer,[1] by *J. W. Westwater*, Univ. of Illinois

4 TUESDAY, NOVEMBER 29 8:00 p.m.

Radiation Processes

Recent Studies on Quantitative Spectroscopy and Gas Emissivities[1], by *S. S. Penner*, California Inst. of Tech., *D. B. Olfe*, and *M. Lapp*

Gaseous Radiation With Temperature Gradients, by *H. C. Hottel*, M.I.T.

Thermal Radiation Characteristics of Surfaces,[1] by *R. V. Dunkle*, Commonwealth Scientific & Industrial Res. Organization, Victoria, Australia

5 WEDNESDAY, NOVEMBER 30 9:30 a.m.

Convective Processes and Panel Discussion

Plasma Heat Transfer,[1] by *H. W. Emmons*, Harvard Univ.

The panel will be comprised of all speakers listed on sessions 2, 3, 4, and 5.

6 WEDNESDAY, NOVEMBER 30 2:30 p.m.

Forced Convection

Fully Developed Pressure Drop in Triangular Shaped Ducts, by *L. W. Carlson*, Rocketdyne, Div. of North American Aviation, Inc., and *T. F. Irvine, Jr.*, North Carolina State College (Paper No 60—WA-100)

A Comparison of Predicted and Measured Friction Factors for Turbulent Flow Through Rectangular Ducts, by *J. P. Hartnett*, Univ. of Minnesota, *J. C. Y. Koh*, Boeing Airplane Co., and *Stuart McComas*, Univ. of Minnesota (Paper No. 60—WA-198)

Investigation of the Nonisothermal Friction Factor in the Turbulent Flow of Liquids, by *D. A. Wiederecht*, Westinghouse Elec. Corp., and *George Sonnemann*, Univ. of Pittsburgh (Paper No. 60—WA-82)

An Exact Solution of the Compressible Flow Characteristics in Constant Area Passages With Simultaneous Friction and Constant Heat Flux, by *R. N. Noyes*, Gen. Elec. Co. (Paper No 60—WA-177)

The Effect of a Longitudinal Magnetic Field on Pipe Flow of Mercury,[2] by *Samuel Globe*, AVCO Corp. (Paper No. 60—WA-192)

On Some Laminar Forced Convection Problems, by *L. N. Tao*, Illinois Inst. of Tech. (Paper No. 60—WA-188)

[2] Not presented orally.

7 WEDNESDAY, NOVEMBER 30 8:00 p.m.

Boundary Layers and Related Topics

Effect of Hydrogen Recombination on Turbulent Flow Heat Transfer, by *W. H. Gieda*, Univ. of California, *L. L. Cobb, Jr.*, Sandia Corp., and *E. J. Russ*, Gen. Dynamics Corp. (Paper No. 60—WA-256)

Experimental Ablation Rates in a Turbulent Boundary Layer, by *E. P. Bartlett* and *M. R. Denison*, Aeronutronic, Div. of Ford Motor Co. (Paper No. 60—WA-208)

An Investigation of Porous Wall Cooling, by *R. P. Bernicker*, M.I.T. (Paper No. 60—WA-233)

Local Mass Transfer From Circular Cylinders in Cross Flow, by *H. H. Sogin*, Tulane Univ. and *V. S. Subramanian*, Union Carbide of India, Ltd., Calcutta, India (Paper No. 60—WA-193)

Unsteady Laminar Free Convection, by *P. M. Chung*, NASA, Ames Res. Center and *A. D. Anderson*, Lockheed Aircraft Corp. (Paper No. 60—WA-211)

Buoyancy Effects in Forced Laminar Convection Flow Over a Horizontal Flat Plate, by *Yasuo Mori*, Cornell Univ. (Paper No. 60—WA-220)

8 THURSDAY, DECEMBER 1 9:30 a.m.

Radiation

Correlation of the Total Emissivity of Carbon Dioxide and Water Vapor, by *J. T. Bevans*, Space Technology Labs., Inc. (Paper No. 60—WA-175)

Radiation Interchange in a Nongray Enclosure Containing an Isothermal Carbon-Dioxide-Nitrogen Gas Mixture, by *D. K. Edwards*, Univ. of California (Paper No. 60—WA-210)

Radiant Interchange Between Circular Disks Having Arbitrarily Different Temperatures, by *E. M. Sparrow*, Univ. of Minnesota, and *J. L. Gregg*, NASA, Lewis Res. Center (Paper No. 60—WA-75)

Design of a Heat-Rejection System for the SNAP 2 Space Nuclear Power System, by *R. A. Stone* and *M. G. Coombs*, Atomic Intl., Div. of North American Aviation, Inc. (Paper No. 60—WA-237)

Shell Radiation, by *J. W. Tatom*, Lockheed Aircraft Corp. (Paper No. 60—WA-234)

9 THURSDAY, DECEMBER 1 2:30 p.m.

Change of Phase

A Correlation of Local Pressure Gradients for Subcooled Boiling of Water in Vertical Tubes, by *W. L. Owens, Jr.*, Univ. of Aberdeen, Aberdeen, Scotland, and *V. E. Schrock*, Univ. of California (Paper No. 60—WA-249)

Film-Boiling Heat Transfer From a Horizontal Surface, by *P. J. Berenson*, M.I.T. (Paper No. 60—WA-147)

Oscillations in Two-Phase Flow Systems, by *G. B. Wallis*, Atomic Energy Establishment, Dorchester, Dorset, England, and *J. H. Heasley*, Microtech Research Co. (Paper No. 60—WA-209)

Film Boiling in a Forced-Convection Boundary-Layer Flow, by *R. D. Cess*, North Carolina State College, and *E. M. Sparrow*, Univ. of Minnesota (Paper No. 60—WA-148)

An Integral Treatment of Two-Phase Boundary Layer in Film Condensation, by *J. C. Y. Koh*, Boeing Airplane Co. (Paper No. 60—WA-253)

10 FRIDAY, DECEMBER 2 9:30 a.m.

Conduction

Constant Cross-Section Fin Efficiencies for Nonuniform Surface Heat-Transfer Coefficients, by *L. S. Han* and *S. G. Lefkowitz*, The Ohio State Univ. (Paper No. 60—WA-41)

Temperature Distribution in a Slab Moving From a Chamber at One Temperature to a Chamber at Another Temperature, by *G. Horvay*, Gen. Elec. Res. Lab. (Paper No. 60—WA-197)

Thermal Conductivity of Some Commercial Iron-Nickel Alloys, by *T. W. Watson* and *H. E. Robinson*, Nat. Bur. of Stds. (Paper No. 60—WA-47)

Transient Temperature in a Melting Solid,[1] by *J. E. Sunderland*, Northwestern Univ., and *R. J. Grosh*, Purdue Univ.

Steady-State Temperature Distribution in a Counter-Flow Heat Exchanger Including Longitudinal Conduction in the Wall, by *H. G. Landau* and *J. W. Hlinka*, Columbia Univ. (Paper No. 60—WA-236)

[1] Paper not available—see box on page 116.

11 FRIDAY, DECEMBER 2 2:30 p.m.

Biotechnology and Applications

Man in Cold Environments, by *S. M. Horvath*, The Lankenau Hospital, Philadelphia, Pa. (Paper No. 60—WA-240)

Studies on Thermal Effects of Solar Radiation in Transportable Solar Chamber, by *D. H. K. Lee* and *J. A. Vaughan*, U. S. Army Quartermaster Res. & Engrg. Command (Paper No. 60—WA-251)

Problems in Rating Severity of Exposures to Heat, by *H. S. Belding* and *T. F. Hatch*, Univ. of Pittsburgh (Paper No. 60—WA-232)

Application of Peltier Refrigerators to Space Vehicles, by *M. E. Stelzriede*, North American Aviation, Inc. (Paper No. 60—WA-238)

A Comprehensive Approach to the Analysis of Cooling-Tower Performance, by *D. R. Baker* and *H. A. Shryock*, The Marley Co. (Paper No. 60—WA-85)

HUMAN FACTORS SESSIONS

1 THURSDAY, DECEMBER 1 9:30 a.m.

Jointly With Human Factors Society

From Animal's to Man's Locomotion on Land,[1] by *M. G. Bekker*, Ordnance Tank-Automotive Command

The Center of Mass of Man,[1] by *B. G. King, C. T. Patch*, and *P. G. Shinkman*, Operations Res., Inc.

Biomechanical Design of a Lower Extremity Prosthesis,[1] by *C. W. Radcliffe*, Univ. of California

2 THURSDAY, DECEMBER 1 2:30 p.m.

Jointly With Human Factors Society

Some Points of View (Head and Eye Movement Recording),[1] by *N. H. Mackworth*, Dunlap & Assoc.

The Eye as a Servocontrol Mechanism,[1] by *C. T. White*, U. S. Navy Electronics Lab.

Experimental Cerebral Concussion,[1] by *H. R. Lissner* and *E. S. Gurdjian*, Wayne State Univ.

HUMAN FACTORS SOCIETY SESSIONS

THURSDAY, DECEMBER 1 9:30 a.m.

Jointly With Human Factors

See Human Factors 1

THURSDAY, DECEMBER 1 2:30 p.m.

Jointly With Human Factors

See Human Factors 2

HYDRAULIC SESSIONS

1 MONDAY, NOVEMBER 28 9:30 a.m.

Flow Models in Boundary-Layer Stall Inception, by *V. A. Sandborn*, NASA, Lewis Res. Center, and *S. J. Kline*, Stanford Univ. (Paper No. 60—WA-149)

Generalization of a Class of Solutions of the Laminar, Incompressible Boundary-Layer Equations, by *W. O. Winer* and *A. G. Hansen*, Univ. of Michigan (Paper No. 60—WA-159)

2 MONDAY, NOVEMBER 28 2:30 p.m.

Particle Trajectories in a Gas Centrifuge, by *A. R. Kriebel*, Stanford Research Inst. (Paper No. 60—WA-158)

Nonsteady Discharge of Subcritical Flow, by *George Rudinger*, Cornell Aeronautical Lab., Inc. (Paper No. 60—WA-152)

Effects of Inlet Conditions on Performance of Two-Dimensional Subsonic Diffusers, by *B. A. Waitman*, California Inst. of Tech., *L. R. Reneau*, and *S. J. Kline*, Stanford Univ. (Paper No. 60—WA-143)

TUESDAY, NOVEMBER 29 9:30 a.m.

Jointly With Gas Turbine Power and Aviation

See Gas Turbine Power 1

3 TUESDAY, NOVEMBER 29 9:30 a.m.

Inlet and Exit Header Shapes for Uniform Flow Through a Resistance Parallel to the Main Stream, by *Morris Perlmutter*, NASA, Lewis Res. Center (Paper No. 60—WA-160)

The Influence of Tip Clearance on Stall Limits of a Rectilinear Cascade of Compressor Blades, by *Ghassan Khabbaz* and *Yasuloshi Senoo*, M.I.T. (Paper No. 60—WA-163)

Annular Flow of Gas and Liquid in Smooth Pipes,[2] by *M. F. Abdel Aziz*, Cairo Univ., Cairo, Egypt (Paper No. 60—WA-161)

TUESDAY, NOVEMBER 29 2:30 p.m.

Jointly With Gas Turbine Power and Aviation

See Gas Turbine Power 2

4 TUESDAY, NOVEMBER 29 2:30 p.m.

Symposium: Scale Effects on Cavitation—Part 1

Theory of Scale Effects on Cavitation Inception in Axial Symmetric Bodies, by *Ryoichiro Oshima*, Hitachi Works, Ltd., Sukegawacho, Hitachi-City, Ibaragi-Prefecture, Japan (Paper No. 60—WA-136)

Scale Effects on Cavitation, by *J. W. Holl*, Univ. of Nebraska, and *G. F. Wislicenus*, Pennsylvania State Univ. (Paper No. 60—WA-151)

Cavitation Along Surfaces of Separation, by *D. W. Appel*, Univ. of Kansas (Paper No. 60—WA-265)

TUESDAY, NOVEMBER 29 8:00 p.m.

Jointly With Gas Turbine Power and Aviation

See Gas Turbine Power 3

5 TUESDAY, NOVEMBER 29 8:00 p. m.

Symposium: Scale Effects on Cavitation—Part 2

The Effect of Speed on the Cavitation Performance of an Inducer at Suction Specific Speeds up to 25,000,[1] by *John Montgomery* and *James Crouse*, NASA, Lewis Res. Center

Use of Model to Disclose Effects of Cavitation in Penstock Wye-Branch, by *H. E. Burrier*, Southern California Edison Co. (Paper No. 60—WA-153)

Note on the Observations of Cavitation in Different Fluids, by *L. R. Sarosdy*, U. S. Navy, and *A. J. Acosta*, California Inst. of Tech. (Paper No. 60—WA-83)

6 WEDNESDAY, NOVEMBER 30 9:30 a.m.

Symposium: Flow Visualization and Time Varying Flow Measurements—Part 1

Keynote Lecture—Importance and Use of Flow Visualization Methods,[6] by *S. J. Kline*, Stanford Univ.

Flow Visualization in Two or Three-Dimensional Flow Fields by the Use of Smoke Filaments,[6] by *A. M. Lippisch*, Collins Radio Co.

The Injection of Dye for Flow Visualization,[2] by *F. R. Hama*, Univ. of Maryland

Neutral Density Beads for Flow Visualization,[6] by *Merton Allen*, Gen. Elec. Co.

Flow Visualization Using Tufts in Turbomachinery,[6] by *D. R. Seyler*, Gen. Elec. Co.

Wall-Trace Techniques,[6] by *Kurt Frey*, Univ. of Delaware

[2] Not presented orally.

[6] A bound volume of all papers presented at this Symposium will be available at the session.

Flow Visualization by Means of the Electrolysis of Water,[6] by *A. M. O. Smith*, Douglas Aircraft Co., Inc.

Spark-Discharge Methods for Indicating Flow Profiles,[6] by *J. R. Weske*, Univ. of Maryland

7 WEDNESDAY, NOVEMBER 30 2:30 p.m.

Symposium: Flow Visualization and Time Varying Flow Measurements—Part 2

Streaming Birefringence as a Qualitative and Quantitative Flow-Visualization Tool,[6] by *J. H. Wayland*, California Inst. of Tech.

Extensions and Limitations of Schlieren and Shadowgraph Methods,[6] by *J. M. Simonsen*, Brigham Young Univ.

The Use of Schlieren Methods With Moving Shock Fronts,[6] by *A. K. Oppenheim*, Univ. of California

The Application of Interferometry to Time Varying Flow Conditions,[6] by *E. R. G. Eckert*, Univ. of Minnesota

Methods Useful to Observing the Flow in Very Low Density Fields,[6] by *F. Hurlbut*, Univ. of California

Modern Developments in High-Speed Photography,[6] by *H. E. Edgerton*, M.I.T.

High-Speed Photographic Methods to Observe Unsteady Combustion in Rocket Chambers,[6] by *K. N. Watts*, Rocketdyne, Div. of North American Aviation, Inc.

Photographic Methods of Observing Cavitation,[6] by *A. T. Ellis*, California Inst. of Tech.

8-A THURSDAY, DECEMBER 1 9:30 a.m.

The Hydraulic Analogy Applied to Nonsteady, Two-Dimensional Flow in the Partial-Admission Turbine, by *H. K. Heen*, Eastman Kodak Co., and *R. W. Mann*, M.I.T. (Paper No. 60—WA-168)

The Jet-Flap Compressor Cascade, by *E. F. Brocher*, Therm, Inc.; Cornell Univ. (Paper No. 60—WA-165)

Transport Processes Involving a Moving Rotating Disk in a Low-Density Gas, by *S. L. Soo*, Univ. of Illinois (Paper No. 60—WA-154)

8-B THURSDAY, DECEMBER 1 9:30 a.m.

Analysis of a Complex Transient Hydraulic Problem in the Power Industry, by *E. H. Taylor*, Univ. of California, *A. Reisman*, Los Angeles State College, *E. Deland*, RAND Corp., and *H. H. Baudistel, Jr.*, Dept. of Water & Power, Los Angeles, Calif. (Paper No. 63—WA-5)

Pressure Surges Following Water-Column Separation, by *J. T. Kephart, Jr.*, and *Kenneth Davis*, E. I. du Pont de Nemours & Co., Inc. (Paper No. 60—WA-120)

Regulation of a Hydraulic Turbine Calculated by the Step-by-Step Method, by *Ignacy Swiecicki*, Allis-Chalmers Mfg. Co. (Paper No. 60—WA-128)

Effects of Brine Dispersion in the Allen Salt Velocity Method, by *L. J. Hooper*, Worcester Polytechnic Inst. (Paper No. 60—WA-138)

9-A THURSDAY, DECEMBER 1 2:30 p.m.

An Investigation of Axial Flow-Pump Design, by *Y. K. Gayed* and *Sami Mikhail*, Cairo Univ., Giza, Egypt (Paper No. 60—WA-36)

Dissimilarity Laws in Centrifugal Pumps and Blowers, by *A. J. Stepanoff* and *H. A. Stahl*, Ingersoll-Rand Co. (Paper No. 60—WA-145)

9-B THURSDAY, DECEMBER 1 2:30 p.m.

The Flow of Water in Curved Channels of Large Width to Radius Ratio, by *A. W. Marris*, The Univ. of Texas (Paper No. 60—WA-164)

Ejector-Nozzle Flow and Thrust for Choked Flow, by *H. E. Weber*, Gen. Elec. Co. (Paper No. 60—WA-155)

The Two-Dimensional Magnus Effect—A Summary of Investigations to Date, by *W. M. Swanson*, Washington Univ. (Paper No. 60—WA-150)

10 FRIDAY, DECEMBER 2 9:30 a.m.

Patterning Stage Characteristics for Wide-Range Axial Compressors, by *David Wilson*, Northern Res. & Engrg. Corp., London, England (Paper No. 60—WA-113)

Considerations in the Design of Extreme-Range Axial Compressors, by *D. O. Millar*, Allis-Chalmers Mfg. Co. (Paper No. 60—WA-176)

[6] A bound volume of all papers presented at this Symposium will be available at the session.

Inlet Guide Vane Performance of Centrifugal Blowers, by *A. J. Stepanoff*, Ingersoll-Rand Co (Paper No. 60—WA-130)

11 FRIDAY, DECEMBER 2 2:30 p.m.

Symposium: Manufacturers Symposium on Centrifugal and Axial Compressors

Problems of Design and Application of Centrifugal Compressor for Long-Term Continuous Operation,[1] by *Darwin Schmidt*, Ingersoll-Rand Co.

Specifications for Compressors,[1] by *C. F. Codrington*, Allis-Chalmers Mfg. Co.

Modern Design in Heavy Duty Centrifugal Compressors,[1] by *C. F. Koenig*, De Laval Steam Turbine Co.

Compressor Noise,[1] by *O. A. Smith* and *N. L. Meyerson*, Worthington Corp.

INSTRUMENTS AND REGULATORS SESSIONS

TUESDAY, NOVEMBER 29 8:00 p.m.

Jointly With Aviation

See Aviation 5

WEDNESDAY, NOVEMBER 30 9:30 a.m.

Jointly With Aviation

See Aviation 6-B

1 THURSDAY, DECEMBER 1 9:30 a.m.

Jointly With Gas Turbine Power

The Measurement of High-Frequency Pressure Fluctuations Between Impeller Blades in an Operating Gas-Turbine Compressor,[1] by *Peter Stein*, Arizona State Univ.

Stress Analysis of a Radial Flow Rotor, by *M. J. Schilhansl*, consulting engr., Cranston, R. I. (Paper No. 60—WA-200)

Frequency-Response Analysis of a Hydraulic Servomechanism With Several Nonlinearities, by *J. Van deVegte*, Univ. of Toronto, Toronto, Ont. Canada (Paper No. 60—WA-45)

Transfer Function Derivation and Verification for a Toric Variable Speed Drive,[2] by *J. L. Harned, P. Sudhindranath, K. M. Miller*, and *R. J. Roddy*, Gen. Motors Tech. Center (Paper No. 60—WA-184)

2 THURSDAY, DECEMBER 1 2:30 p.m.

Jointly With Mechanical Pressure Elements

Dynamic Characteristics of Some Valve-Actuator Hydraulic Controls, by *V. C. Tsien*, Cleveland Pneumatic Tool Co. (Paper No. 60—WA-54)

Dynamic Behavior of a Simple Pneumatic Pressure Reducer, by *D. H. Tsai* and *E. C. Cassidy*, Nat. Bureau of Stds. (Paper No. 60—WA-186)

Identification of Process Parameters by Means of Learning Models, by *Herman Thal-Larsen* and *Y. Takahashi*, Univ. of California (Paper No. 60—WA-121)

Bibliography on Diaphragms and Bellows,[2] by *L. M. Van der Pyl*, Rockwell Mfg. Co. (Paper No. 60—WA-122)

3 FRIDAY, DECEMBER 2 9:30 a.m.

Mixing Studies in a Shell and Tube Heat Exchanger, by *G. C. Vincent*, Monsanto Chemical Co. (Paper No. 60—WA-261)

On the Dynamics of Steam/Liquid Heat Exchangers, by *Arvid Hempel*, Chr. Michelsen Inst., Bergen, Norway (Paper No. 60—WA-110)

Dynamic Response of Heat Exchangers Having Internal-Heat Sources—Part 4, by *Wen-Jei Yang*, Mitsui Engrg. & Shipbuilding Co., Tamano, Okayama, Japan, *J. A. Clark* and *V. S. Arpaci*, Univ. of Michigan (Paper No. 60—WA-127)

[1] Paper not available—see box on page 116.
[2] Not presented orally.

JUNIOR SESSION

WEDNESDAY, NOVEMBER 30 8:00 p.m.

Help in Developing the Young Engineer,[2] by *John Gammell*, Allis-Chalmers Mfg. Co.

How Participation in Professional Activities Can Aid the Young Engineer,[2] by *Albert Underwood, Jr.*, Ford Motor Co. of Canada, Ltd., Windsor, Ont., Canada

Benefits I Derived From ASME,[2] by W. *M Morley*, Stock Equipment Co.

LUBRICATION SESSIONS

THURSDAY, DECEMBER 1 2:30 p.m.

Jointly With Research Committee on Lubrication

See Research Committee on Lubrication

FRIDAY, DECEMBER 2 9:30 a.m.

Review of ASME-ASLE 1960 Lubrication Conference,[1] by *E. G. Jackson*, Nat. Res. Corp.

The 1960 ASME Spring Lubrication Symposium, by *H. A. Hartung*, Atlantic Refining Co.

Lubrication Research—Digest of 1959-1960 Literature,[1] by *Paul Lewis*, Gen. Elec. Co.

Review of Friction and Wear Literature,[1] by *M. B. Peterson*, Gen. Elec. Co.

Boundary Lubrication,[1] by *S. F. Murray*, Gen. Elec. Co.

Metalworking Lubrication,[1] by *A. F. Gerds*, Battelle Memorial Inst.

Automotive Lubricants,[1] by *J. M. Cunningham*, Gulf Res. & Dev. Co.

Gear Lubrication,[1] by *M. Godet*, Shell Dev. Co.

Rolling Element Bearings Literature Survey,[1] by *W. J. Anderson*, NASA, Lewis Res. Center

Lubricant Properties,[1] by *A. A. Schwartz*, Gen. Elec. Co.

Digest of 1959 Literature on Fluid-Film Bearings,[1] by *E. B. Arwas*, Gen. Elec. Co. and *F. W. Ocvirk*, Cornell Univ.

RESEARCH COMMITTEE ON LUBRICATION SESSION

THURSDAY, DECEMBER 1 2:30 p.m.

Jointly With Lubrication

Theory of Lubrication and Failure of Rolling Contacts,[2] by *B. Sternlicht* and *Paul Lewis*, Gen. Elec. Co.

Air-Hammer Instability in Pressurized Journal Gas Bearings, by *L. Licht*, The Franklin Inst. (Paper No. 60—WA-10)

Critical Factors in the Evaluation of Solid Lubricants at Temperatures Up to 1200 F,[2] by *A. E. Bowen, Jr.*, The Alpha Molykote Corp., and *W. E. Campbell*, consultant, Cleveland, Ohio

MACHINE DESIGN SESSIONS

1 TUESDAY, NOVEMBER 29 9:30 a.m.

A Tabular Collocation Method for Beam Vibrations, by *Ricardo Chicurel*, Virginia Polytechnic Inst., and *E. W. Suppiger*, Princeton Univ. (Paper No. 60—WA-76)

Balancing Flexible Rotors, by *A. H. Church*, New York Univ., and *Robert Plunkett*, Univ. of Minnesota (Paper No. 60—WA-13)

Critical Speeds of Two Bearing Machines With Overhung Weight, by *R. F. Wojnowski*, IBM Corp., and *T. R. Faucett*, Univ. of Missouri (Paper No. 60—WA-39)

2 TUESDAY, NOVEMBER 29 2:30 p.m.

The Flexural Vibrations of Thin Laminated

Cylinders, by *J. C. White*, Gen. Elec. Co. (Paper No. 60—WA-6)

Damping Structural Resonances Using Viscoelastic Shear-Damping Mechanisms—Part 1: Design Configurations, by *J. E. Rusicka*, Barry Controls Inc. (Paper No. 60—WA-73)

Damping Structural Resonances Using Viscoelastic Shear-Damping Mechanisms—Part 2: Experimental Results, by *J. E. Rusicka*, Barry Controls Inc. (Paper No. 60—WA-72)

Stress and Strain in Spinning Paraboloid Dishes—2, by *M. J. Cohen*, Northampton College of Advanced Technology, London, England (Paper No. 60—WA-91)

3 TUESDAY, NOVEMBER 29 8:00 p.m.

Loosening of Bolted Joints by Small Plastic Deformations, by *O. A. Pringle*, Univ. of Missouri (Paper No. 60—WA-116)

The Dynamic Frictional Characteristics of Molded Frictional Materials, by *M. J. Rabins*, New York Univ., and *R. J. Harker*, Univ. of Wisconsin (Paper No. 60—WA-35)

On the Determination of the Influence of an Axial Pre-Load Due to Bolting on a Cylindrical Pressure Vessel, by *P. R. Paslay*, The Rice Institute. (Paper No. 60—WA-133)

Kinematics: A German-English Glossary,[2] by *T. P. Goodman*, Gen. Elec. Co., and *R. S. Hartenberg*, Northwestern Univ. (Paper No. 60—WA-48)

4 WEDNESDAY, NOVEMBER 30 9:30 a.m.

Wear Limits for Roller and Silent Chain Drives, by *H. S. Germond*, Morse Chain Co. (Paper No. 60—WA-8)

Kinematics of a General Arrangement of Two Hooke's Joints, by *R. E. Philipp*, U. S. Military Academy (Paper No. 60—WA-37)

Tension Variations in V-Belts Applied to Locked Center Drives,[1] by *K. G. Hornung, S. M. Marco*, and *W. L. Starkey*, Ohio State Univ.

5 WEDNESDAY, NOVEMBER 30 2:30 p.m.

Optimum Design of Helical Compression Springs, by *R. J. Erisman*, Intl. Harvester Co. (Paper No. 60—WA-215)

U Springs and Deflection Calculations, by *J. E. Fleckenstein*, Johnson Service Co. (Paper No. 60—WA-172)

Shaft Whirling as Influenced by Stiffness Asymmetry,[1] by *E. H. Hull*, Gen. Elec. Co.

6 THURSDAY, DECEMBER 1 9:30 a.m.

Free Oscillations of Edge-Connected Simply Supported Plate Systems, by *E. E. Ungar*, Bolt Beranek & Newman Inc. (Paper No. 60—WA-112)

The Centrifugal Clutch Coupling, by *J. E. Ettorre*, The Hilliard Corp. (Paper No. 60—WA-173)

Magnetic Properties of Malleable Irons,[1] by *W. K. Bock*, Nat. Malleable & Steel Castings Co. and *T. D. Hutchinson*, Malleable Res. & Dev. Foundation (Paper No. 60—WA-218)

MAINTENANCE

SESSION

MONDAY, NOVEMBER 28 2:30 p.m.

Process-Equipment-Performance Analysis for Increased Production,[1] by *J. D. Quinn*, E. I. du Pont de Nemours & Co., Inc.

Patent Problems Deriving From Machine Maintenance, by *Bryce Beecher*, Gen. Motors Corp. (Paper No. 60—WA-266)

Development of the Scale Model for Factory Construction and Maintenance, by *M. T. Cutrell*, Procter & Gamble Mfg. Co. (Paper No. 60—WA-267)

MANAGEMENT

SESSIONS

Golden Jubilee of Scientific Management—Ten Years' Progress, 1950–1960

1 TUESDAY, NOVEMBER 29 9:30 a.m.

Progress in General Management—Part 1

Management's Past—A Guide to Its Future,[3] by *Lillian M. Gilbreth*, New York, N. Y., and *W. B. Jaffe*, Newark College of Engrg. (Paper No. 60—WA-67)

Philosophy of Management,[3] by *A. M. Lederer*, A. M. Lederer & Co., Inc. (Paper No. 60—WA-56)

Philosophy of Management,[3] by *L. F. Urwick*, Urwick House, London, England (Paper No. 60—WA-55)

Management as a Profession,[3] by *H. F. Smiddy*, Gen. Elec. Co. (Paper No. 60—WA-61)

2 TUESDAY, NOVEMBER 29 2:30 p.m.

Progress in General Management—Part 2

Fifty Years of Management—A Look Back—And a Look Forward,[3] by *P. F. Drucker*, consultant, Montclair, N. J. (Paper No. 60—WA-46)

Practices in General Management—Organization,[3] by *B. J. Muller-Thym*, consultant, New York, N. Y. (Paper No. 60—WA-59)

Practices in General Management—Financial,[3] by *R. B. Curry*, Southern Railway System (Paper No. 60—WA-66)

Practices in General Management—Measurements and Control,[3] by *A. W. Rathe*, New York Univ. (Paper No. 60—WA-69)

3 TUESDAY, NOVEMBER 29 8:00 p.m.

Progress in Operational Management—Part 1

Practices in Operational Management—Personnel Management,[3] by *C. E. French*, Industrial Relations Counselors, Inc. (Paper No. 60—WA-64)

Practices in Operational Management—Distribution Management,[3] by *J. R. Hawkinson*, Northwestern Univ. (Paper No. 60—WA-57)

Practices in Operational Management—Federal Government,[3] by *H. K. Hyde*, Dept. of Defense (Paper No. 60—WA-169)

Practices in Operational Management—Local Government and Other Nonprofit Organizations,[3] by *G. M. Goettelman*, Philadelphia, Pa. (Paper No. 60—WA-126)

4 WEDNESDAY, NOVEMBER 30 9:30 a.m.

Progress in Operational Management—Part 2

Practices in Operational Management—The Management of Industrial Research,[3] by *H. K. Work*, New York Univ. (Preface by *August Kinzel*, Union Carbide Corp.) (Paper No. 60—WA-58)

Practices in Operational Management—Engineering Management,[3] by *C. E. Paules*, (retired) Esso Res. & Engrg. Co. (Paper No. 60—WA-50)

Practices in Operational Management—Manufacturing Management,[3] by *H. B. Maynard*, Maynard Res. Council (Paper No. 60—WA-60)

Management Science,[3] by *E. H. Weinwurm*, De Paul Univ. (Paper No. 60—WA-65)

5 WEDNESDAY, NOVEMBER 30 2:30 p.m.

Progress in Management Education

Management Education—Colleges and Universities,[3] by *E. P. Brooks*, M.I.T. (Paper No. 60—WA-62)

Management Education—Professional Societies and Associations?[3] by *C. E. Davies*, United Engrg. Center Project (Paper No. 60—WA-109)

Management Education—Industrial,[3] by *F. F. Bradshaw*, management consultant, Croton-on-Hudson, N. Y. (Paper No. 60—WA-107)

International Progress in Management,[3] by *Erich Mittelsten-Scheid*, Vorwerk & Co., KG, Wuppertal-Barmen, Germany (Paper No. 60—WA-68)

THURSDAY, DECEMBER 1 9:30 a.m.

Jointly With Process Industries

See Process Industries 1

[1] Paper not available—see box on page 116.
[2] Not presented orally.

[3] A bound volume entitled, "Fifty Years' Progress in Management," consisting of all papers presented at the five Management Sessions will be available for purchase at the Technical Papers Desk and Publications Display Booth on the Mezzanine of the Statler Hilton Hotel during the meeting. Price: $10.50; to ASME members, $8.40.

MATERIALS HANDLING

SESSIONS

1 MONDAY, NOVEMBER 28 9:30 a.m.

Materials-Handling Transportation—Fork Truck Versus Trailer Train, by *F. C. Winter*, Columbia Univ. (Paper No. 60—WA-101)

Synchronization of Conveyer Drives, by *J. C. Webb*, Jervis B. Webb Co. (Paper No. 60—WA-223)

2 TUESDAY, NOVEMBER 29 9:30 a.m.

Mechanized Warehousing of Case Goods, by *A. Spinanger*, The Procter & Gamble Co. (Paper No. 60—WA-95)

Research in Bulk-Materials Handling, by *M. J. Erisman*, Link-Belt Co.

Methods Engineering in Materials Handling, by *J. C. Somers*, Industrial Products Engrg. Co. (Paper No. 60—WA-99)

MECHANICAL ENGINEERING DEPARTMENT HEADS

SESSION

WEDNESDAY, NOVEMBER 30 8:00 p.m.

Part 1—Design

The Artist Engineer,[2] by *C. J. Freund*, Univ. of Detroit

Some Principles of Mechanical Design,[2] by *A. H. Burr*, Cornell Univ.

Report on First Engineering Design-Education Conference,[2] *speaker to be announced*

Part 2—Mechanical Laboratory

Some Problems in Mechanical-Laboratory Instruction,[2] by *K. R. Wadleigh*, M.I.T.

Progress Report on Development of NSF Mechanical-Engineering Laboratory Studies,[2] by *J. B. Hartman*, Lehigh Univ., and *J. F. Lee*, North Carolina State College

MECHANICAL PRESSURE ELEMENTS

SESSION

THURSDAY, DECEMBER 1 2:30 p.m.

Jointly With Instruments and Regulators

See Instruments and Regulators 2

METALS ENGINEERING

SESSIONS

TUESDAY, NOVEMBER 29 2:30 p.m.

Jointly With Applied Mechanics

See Applied Mechanics 4

1 WEDNESDAY, NOVEMBER 30 9:30 a.m.

Panel Discussion: Residual Stresses

2 WEDNESDAY, NOVEMBER 30 2:30 p.m.

Short-Time Tensile Properties of Type 316 Stainless Steel at Very-High Temperatures, by *T. W. Gibbs* and *H. W. Wyatt*, AVCO Corp. (Paper No. 60—WA-11)

Tensile Properties of Types 304 and 347 Austenitic Stainless Steel in the Temperature Range From 80 F to 800 F, by *W. H. Pryle* and *E. T. Wessel*, Westinghouse Res. Labs. (Paper No. 60—WA-9)

Empirical Correlation of Maximum Load Data From Published Brittle and Ductile Fracture Tests of Centrally Loaded Plates and Sheets, by *A. G. Holms*, NASA, Lewis Res. Center (Paper No. 60—WA-135)

3 WEDNESDAY, NOVEMBER 30 8:00 p.m.

Effect of Combined Stress on Yield and Fracture Behavior of Zircaloy-2, by *R. L. Mehan*, Gen. Elec. Co. (Paper No. 60—WA-96)

[3] Not to be printed.

Effect of Cell Geometry on the Shear Modulus and on Density of Sandwich Panel Cores, by *Chieh-Chien Chang* and *I. K. Ebcioglu*, Univ. of Minnesota (Paper No. 60—WA-52)

The Fabrication of Thin-Wall Molybdenum Shapes by Welding, by *W. F. Brown* and *M. A. Pugacz*, Gen. Elec. Co. (Paper No. 60—WA-53)

4 THURSDAY, DECEMBER 1 9:30 a.m.

Jointly With Petroleum

Bursting of Tubular Specimens by Gaseous Detonations, by *P. N. Randall* and *Irwin Ginsburgh*, Standard Oil Co. (Indiana) (Paper No. 60—WA-12)

Thermal Stress Analysis of Irregular Shapes, by *P. P. Bijlaard*, Cornell Univ., and *R. J. Dohrmann*, The Babcock & Wilcox Co. (Paper No 60—WA-131)

A Theory of Fatigue Damage, by *R. R. Gatts*, Gen. Elec. Co. (Paper No. 60—WA-144)

NUCLEAR ENGINEERING SESSIONS

1 MONDAY, NOVEMBER 28 9:30 a.m.

Jointly With Power

Panel Discussion: Some Methods of Direct Conversion of Energy

Thermionic Converters,[2] by *R. W. Pidd*, Gen. Atomic, Div. of Gen. Dynamics Corp.

Thermoelectric Power Generation,[2] by *F. H. Horn*, Gen. Elec. Res. Lab.

Fuel Cells,[2] *speaker to be announced*

Magnetohydrodynamics,[2] by *Stewart Way*, Westinghouse Elec. Corp.

2 MONDAY, NOVEMBER 28 2:30 p.m.

Jointly With Power

Panel Discussion: Design and Status Reports on Large Power Reactors

The Status of the Dresden Nuclear Power Station,[2] by *H. K. Hoyt*, Commonwealth Edison Co.

Yankee Atomic Electric Plant,[2] by *G. A. Reed*, Yankee Atomic Elec. Co.

Status Report of the Enrico Fermi Atomic Power Plant,[2] by *C. H. Clark*, The Detroit Edison Co.; Power Reactor Dev. Co.

Indian Point Station,[2] by *R. H. Freyberg*, Consolidated Edison Co. of N. Y.

3 TUESDAY, NOVEMBER 29 9:30 a.m.

Design and Status Report of the Experimental Breeder Reactor II,[2] by *L. J. Koch*, Agonne Nat. Lab.

The Design and Status of the Reactor and Pilot Plant for the Plutonium Recycle Program, by *R. M. Fryar*, Gen. Elec. Co. (Paper No. 60—WA-225)

Economics of Spectral Shift Control,[2] by *R. W. Deuster* and *Zelvin Levine*, The Babcock & Wilcox Co.

TUESDAY, NOVEMBER 29 9:30 a.m.

Jointly With Safety

See Safety 3

TUESDAY, NOVEMBER 29 2:30 p.m.

Jointly With Safety

See Safety 4

4 TUESDAY, NOVEMBER 29 8:00 p.m.

Jointly With Power

A Binary Vapor Nuclear Power Plant,[1] by *J. K. Salisbury*, consulting engr., Atherton, Calif., and *D. R. Sawle*, Aerojet Gen. Nucleonics

Steady-State Fluid Fow in a Closed Loop With Two Parallel Channels,[1] by *T. R. Bump*, Argonne Nat. Lab.

[1] Paper not available—see box on page 116.
[2] Not to be printed.

Transient Thermal Stresses in Tubular Reactor Fuel Elements, by *L. I. Deverall*, Univ. of California (Paper No. 60—WA-248)

OIL AND GAS POWER SESSION

TUESDAY, NOVEMBER 29 2:30 p.m.

Supercharging of a Large Two-Cycle, Loop Scavenged Diesel Engine, by *A. J. Henriksen*, Nordberg Mfg. Co. (Paper No. 60—WA-185)

Design, Performance, and Exploitation Results of a 25,500-kw Electrical Power Station, by *M. E. Barthalon*, S.I.G.M.A., Paris, France (Paper No. 60—WA-199)

Research on Charge Stratification of Spark-Ignition Engines,[1] by *L. D. Conta* and *Pandeli Durbetaki*, Univ. of Rochester

Diagram for Conversion of Diesel Engine Out-Puts for Changed Atmospheric Conditions,[2] by *Soren Hansen*, Burmeister & Wains, Maskin-og Skibsbyggeri, Copenhagen, Denmark (Paper No. 60—WA-162)

PETROLEUM SESSIONS

1 WEDNESDAY, NOVEMBER 30 9:30 a.m.

Natural Gas—The Pipeline Industry, by *B. D. Goodrich*, Texas Eastern Transmission Corp. (Paper No. 60—WA-43)

Design and Operation of a Large Marine Terminal Handling Crude Oil, by *W. P. Binger*, Shell Pipe Line Co. (Paper No. 60—WA-42)

2 WEDNESDAY, NOVEMBER 30 2:30 p.m.

Suggested Design Requirements for an Improved Pressure Vessel Code,[1] by *C. A. Honigsberg* and *G. P. Eschenbrenner*, The M. W. Kellogg Co.

A Further Reappraisal of Balanced Pressure Vessel Construction and Classification,[1] by *J. J. Murphy* and *D. B. Rossheim*, The M. W. Kellogg Co.

3 WEDNESDAY, NOVEMBER 30 8:00 p.m.

The Yielded Compound Cylinder in Generalized Plane Strain, by *S. J. Becker*, Westinghouse Elec. Corp. (Paper No. 60—WA-71)

Deflection of Heat-Exchanger Flanged Joints as Affected by Barreling and Warping, by *W. M. Dudley*, Standard Oil Co. (Indiana) (Paper No. 60—WA-70)

Stresses in a Pipe Bent Into a Circular Arc, by *N. A. Weil*, Armour Res. Foundation, *J. E. Brock*, U. S. Naval Postgraduate School, and *W. E. Cooper*, Gen. Elec. Co. (Paper No. 60—WA-157)

THURSDAY, DECEMBER 1 9:30 a.m.

Jointly With Metals Engineering

See Metals Engineering 4

POWER SESSIONS

MONDAY, NOVEMBER 28 9:30 a.m.

Jointly With Nuclear Engineering

See Nuclear Engineering 1

MONDAY, NOVEMBER 28 2:30 p.m.

Jointly With Fuels

See Fuels 2

MONDAY, NOVEMBER 28 2:30 p.m.

Jointly With Nuclear Engineering

See Nuclear Engineering 2

[2] Not presented orally.

TUESDAY, NOVEMBER 29 8:00 p.m.

Jointly With Nuclear Engineering

See Nuclear Engineering 4

1 WEDNESDAY, NOVEMBER 30 9:30 a.m.

Test-Boiler Facility for Testing the Main Propulsion Machinery and Auxiliary Equipment of Nuclear Powered Ships and Submarines, by *F. J. Myers*, Newport News Shipbuilding & Dry Dock Co. (Paper No. 60—WA-146)

Vessel-Component Performance Since World War II, by *E. S. Shulters* and *F. H. Van Riper*, Office of Ship Construction, U. S. Dept. of Commerce (Paper No. 60—WA-132)

Ventilation of Eddystone Station—An Approach to Ventilation of Modern Steam-Electric Generating Stations, by *S. J. Kowalski*, Philadelphia Elec. Co. (Paper No. 60—WA-44)

Optimizing a Regenerative Steam-Turbine Cycle, by *G. Chiantore*, *D. Borgese*, and *F. Baldo*, Edisonvolta, Milano, Italy, and *J. H. Potter*, Stevens Inst. of Tech. (Paper No. 60—WA-179)

2 WEDNESDAY, NOVEMBER 30 2:30 p.m.

A Simplified Analysis of the No Load Stability of Mechanical-Hydraulic Speed-Control Systems for Steam Turbines, by *M. A. Eggenberger*, Gen. Elec. Co. (Paper No. 60—WA-34)

Economic Generation Planning Using a Digital Computer, by *W. J. Fahrner* and *C. M. Heidel*, Detroit Edison Co. (Paper No. 60—WA-156)

Does Condensing Water Affect the River? by *M. D. Engle*, Pennsylvania Power & Light Co. (Paper No. 60—WA-92)

3 THURSDAY, DECEMBER 1 9:30 a.m.

Economy of Efficient Air Preheating With Extraction Steam, by *M. K. Drewry*, Wisconsin Elec. Power Co. (Paper No. 60—WA-94)

Methods for Measuring Steam-Turbine-Generator Performance, by *K. C. Cotton* and *J. C. Westcott*, Gen. Elec. Co. (Paper No. 60—WA-139)

Transient Loading Improvements for Large Steam-Electric-Generating Units, by *Charles Strohmeyer, Jr.*, Gilbert Associates, Inc. (Paper No. 60—WA-51)

4 THURSDAY, DECEMBER 1 2:30 p.m.

Methods of Obtaining Accurate Boiler-Water Level Indication, by *J. W. Williams*, Yarnall-Waring Co. (Paper No. 60—WA-74)

Power-Plant Performance Monitoring, by *J. K. Salisbury*, consulting engr., Atherton, Calif. (Paper No. 60—WA-222)

The Application of the Deviation Concept of Turbine-Cycle Monitoring,[1] by *H. T. Hoffman*, Bailey Meter Co., and *C. P. Welch*, The Babcock & Wilcox Co.

FRIDAY, DECEMBER 2 9:30 a.m.

Jointly With Boiler Feedwater Studies

See Boiler Feedwater Studies 1

FRIDAY, DECEMBER 2 2:30 p.m.

Jointly With Boiler Feedwater Studies

See Boiler Feedwater Studies 2

POWER TEST CODES SESSIONS

1 MONDAY, NOVEMBER 28 9:30 a.m.

The Effects of Measurement Errors on the Calculation of Steam-Generator Efficiency,[1] by *J. H. Born, Jr.*, Foster Wheeler Corp.

Efficiency Determination of Marine Boilers—Input-Output Versus Heat-Loss Method,[1] by *Leonard Cohen* and *W. A. Fritz, Jr.*, U. S. Naval Boiler & Turbine Lab.

2 MONDAY, NOVEMBER 28 2:30 p.m.

A Generalized Approach to One-Dimensiona Gas Dynamics,[1] by *R. P. Benedict* and *W. G. Steltz*, Westinghouse Elec. Corp.

Some Generalizations in One-Dimensional Constant Density Fluid Dynamics,[1] by *W. G. Steltz* and *R. P. Benedict*, Westinghouse Elec. Corp.

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Polytropic Analysis of Centrifugal Compressors,[1] by *J. M. Schultz*, Borg-Warner Corp.

PROCESS INDUSTRIES SESSIONS

1 THURSDAY, DECEMBER 1 9:30 a.m.

Jointly With Management

Value Engineering in the Hard Goods Industry, by *B. W. Eades, Jr.*, Southwestern Industrial Electronics, Div. of Dresser Industries (Paper No. 60—WA-140)

Value Analyzing for Profits, by *F. W. Skeans*, Gen. Foods Corp. (Paper No. 60—WA-129)

Analyzing the Value in Process-Engineering Commodities, by *W. R. Campbell, Jr.*, E. I. du Pont de Nemours & Co., Inc. (Paper No. 60—WA-118)

2 THURSDAY, DECEMBER 1 2:30 p.m.

Air Classification and Fine Grinding, by *W. H. Gellrich*, Alpine American Corp. (Paper No. 60—WA-167)

Gravity Flow of Bulk Solids, by *A. W. Jenike*, Univ. of Utah (Paper No. 60—WA-81)

Low-Temperature Refrigeration, by *A. L. Hesselschwerdt, Jr.*, M.I.T. (Paper No. 60—WA-119)

3 FRIDAY, DECEMBER 2 9:30 a.m.

Some Operating Experiences at a Municipal Refuse Incinerator, by *J. D. Paulus* and *W. M. Harrington, Jr.*, Whitman, Requardt & Assoc. (Paper No. 60—WA-235)

Characterization of Industrial Fabric Filters,[1] by *G. W. Walsh* and *P. W. Spaite*, Robert Taft Sanitary Engrg. Center

PRODUCTION ENGINEERING SESSIONS

1 MONDAY, NOVEMBER 28 9:30 a.m.

Arc Welding for Overlaying Steel,[1] by *R. B. Hitchcock*, E. I. du Pont de Nemours & Co., Inc.

Welded Surface Plates, by *Adolph Kleinsorge*, W. B. Knight Machinery Co. (Paper No. 60—WA-241)

Brazing of Sandwich Structures of Columbium Alloys,[1] by *M. M. Schwartz*, The Martin Co.

2 MONDAY, NOVEMBER 28 2:30 p.m.

Applications for Ultrasonic Welding of Aluminum,[1] by *J. R. Terrill*, Aluminum Co. of America

The Plasma-Arc Torch—Five Years of Evolution,[1] by *R. M. Gage* and *J. F. Pelton*, Linde Co., Div. of Union Carbide Corp.

Practical Implications of the Plasma Torch, by *J. A. Browning* and *G. A. Klasson*, Thermal Dynamics Corp. (Paper No. 60—WA-242)

3 TUESDAY, NOVEMBER 29 9:30 a.m.

Nonmetallics in Production Equipment, by *F. J. Staudt*, E. I. du Pont de Nemours & Co., Inc. (Paper No. 60—WA-245)

Two Quick Nonparametric Statistical Tests for Use by Engineers, by *B. S. Brown*, E. I. du Pont de Nemours & Co., Inc. (Paper No. 60—WA-243)

Tool-Construction Management,[1] by *R. S. Brescka*, Western Elec. Co., Inc.

4 TUESDAY, NOVEMBER 29 2:30 p.m.

Precise Contact Metrology,[1] by *J. C. Paxton, Jr.*, U. S. Naval Weapons Plant

Gage Laboratory—Whys (Wise) and Means,[1] by *Mary E. Hoskins*, The Sheffield Corp.

On the Mechanics of Wire-Drawing, by *C. T. Yang*, The Univ. of Michigan (Paper No. 60—WA-114)

Shear-In Metal Cutting, by *F. L. Bagley, Jr.*, Watertown Arsenal (Paper No. 60—WA-80)

5 WEDNESDAY, NOVEMBER 30 9:30 a.m.

Maintaining High Levels of Weld Quality in a Plutonium Production Plant, by *C. D. Brons*, Gen. Elec. Co. (Paper No. 60—WA-244)

The Economics of Machinery Replacement, by *L. Klein*, Western Elec. Co.

[1] Paper not available—see box on page 116.

Steel-Casting Productivity in Western Europe,[1] by *J. H. Lowe*, Keokuk Steel Casting Co.

Fundamental Machinability Research in Japan, by *Kaisundo Hitomi*, Pennsylvania State Univ. Paper No. 60—WA-78)

6 WEDNESDAY, NOVEMBER 30 2:30 p.m.

A Study of Shear Spinnability of Metals, by *Serope Kalpakcioglu*, The Cincinnati Milling Machine Co. (Paper No. 60—WA-187)

A Theory of Shear Spinning of Cones, by *S. Kobayashi*, Univ. of California, *I. K. Hall*, Pratt & Whitney Aircraft, and *E. G. Thomsen*, Univ. of California (Paper No. 60—WA-134)

Basic Formation of Chips,[1] by *B. H. Amstead* and *R. D. Harris*, Univ. of Texas, and *S. N. Agrawal*, Simpson Elec. Co.

7 THURSDAY, DECEMBER 1 9:30 a.m.

Some Controlled Metal-Cutting Studies With Resulfurized Steels, by *E. G. Thomsen* and *S. Kobayashi*, Univ. of California, and *M. C. Shaw*, M.I.T. (Paper No. 60—WA-115)

An Experimental Investigation of Temperature Distribution at the Tool Flank Surface, by *B. T. Chao*, Univ. of Illinois, *H. L. Li*, E. I. du Pont de Nemours & Co., Inc., and *K. J. Trigger*, Univ. of Illinois (Paper No. 60—WA-87)

Forces on a Worn Cutting Tool, by *H. T. McAdams* and *Paul Rosenthal*, Cornell Aeronautical Lab., Inc. (Paper No. 60—WA-86)

8 THURSDAY, DECEMBER 1 2:30 p.m.

Free-Machining Steel—Part 3: Cutting Forces: Surface Finish and Chip Formation, by *M. C. Shaw, E. Usui*, and *P. A. Smith*, M.I.T. (Paper No. 60—WA-111)

The Application of Cemented Carbides for High-Production Broaching, by *Carroll Edgar*, Univ. of Delaware; E. I. du Pont de Nemours & Co., Inc. (Paper No. 60—WA-117)

The Effects of Electrolytic Assistance in Peripheral Grinding, by *W. R. Backer* and *R. A. Dahlin*, The Norton Co. (Paper No. 60—WA-4)

An Experimental Investigation of the Electrolytic Grinding Process, by *R. R. Cole*, Univ. of California (Paper No. 60—WA-2)

9 FRIDAY, DECEMBER 2 9:30 a.m.

Milling Forces Measured With a Planetary-Gear Torquemeter, by *J. R. Roubik*, Kearney & Trecker Corp. (Paper No. 60—WA-3)

The Flow-Region Theory and Its Application to the Mechanism of Discontinuous Chip Formation, by *Keiji Okushima*, Kyoto Univ., Kyoto, Japan, and *K. Hitomi*, Pennsylvania State Univ. (Paper No. 60—WA-79)

New Developments in the Theory of the Metal-Cutting Process—Part 2, **The Theory of Chip Formation,** by *Paul Albrecht*, The Cincinnati Milling Machine Co. (Paper No. 60—WA-63)

Performance of Carbide Tools in Machining of 18-8 Stainless Steels,[2] by *H. Takeyama*, The Government Lab., Tokyo, Japan (Paper No. 60—WA-1)

PROFESSIONAL PRACTICE COMMITTEE SESSION

TUESDAY, NOVEMBER 29 2:30 p.m.

Panel Discussion: Free Engineering

Relations Between the Consulting Engineer and His Technical Societies,[1] by *J. G. Hoad*, John G. Hoad & Associates, Inc., Consulting Engineers

Manufacturer's Viewpoint,[1] by *F. C. Heller*, The Babcock & Wilcox Co.

RAILROAD SESSIONS

1 THURSDAY, DECEMBER 1 2:30 p.m.

Progress in Railway Mechanical Engineering 1959–1960,[1] by *D. R. Meier*, Gen. Elec. Co.

Mechanical-Engineering Progress on Russian Railroads,[1] by *W. M. Keller*, Assoc. of American Railroads

[2] Not presented orally.

Supplementary Comments on Mechanical Engineering Progress on Overseas Railroads

Operating,[3] by *J. F. Nash*, N. Y. Central Railroad

Electrification,[3] by *J. W. Horine*, Pennsylvania Railroad Co.

Summation,[3] by *C. D. Buford*, Assoc. of American Railroads

[3] Not to be printed.

A Banquet Note

ONE of America's finest speakers and humorists, Canon L. H. Hall, will address the Winter Annual Banquet of The American Society of Mechanical Engineers on December 1. Canon Hall is known both as an outstanding British-American humorist and as Rector of St. Paul's Episcopal Church, Cleveland, Ohio.

Said one who has heard Canon Hall speak before, "I know that he is listed as one of the top ten speakers in the United States. As far as I am concerned, he is one of the top five." His previous talks have drawn capacity audiences in major cities and across the country.

Other features of the banquet will include presentation of Honorary Membership to H. T. Heald of The Ford Foundation, and the ASME Medal to C. Richard Soderberg, Fellow ASME, of M.I.T.

For the ASME banquet, Canon Hall has chosen the topic, "Humor, a Catalyst to Creative Thinking." The son of a famous theatrical family, Canon Hall has an excellent background for the topic.

He was born in England and received most of his formal education there. Although well equipped for the stage by family tradition and personal abilities, he chose, instead, to enter the ministry of the Episcopal Church and, since 1930, has served churches in New York City, Cincinnati, and Cleveland, as well as serving as Chaplain of a number of institutions. In recognition of the notable service he performed as senior Canon-in-Charge of Trinity Episcopal Cathedral in Cleveland, he was elected lifetime Canon of the Cathedral.

The ASME Meetings Department has announced that reservations for individual seats at $15, or for tables of ten at $150, may be made by writing to Meetings Department, The American Society of Mechanical Engineers, 29 West 39th Street, New York 18, N. Y.

2 FRIDAY, DECEMBER 2 9:30 a.m.

Operational Experience With the Chesapeake and Ohio Railway,[1] by *G. J. Sennhauser*, The Chesapeake & Ohio Railway Co.

A New Concept—Push-Pull Suburban Cars, by *William Van Der Sluys*, Pullman-Standard, Div. of Pullman, Inc. (Paper No. 60—WA-264)

Effect of Design of Classification Yards in Reducing Lading Damage,[1] by *A. V. Dasburg*, Gen. Railway Signal Co.

3 FRIDAY, DECEMBER 2 2:30 p.m.

Tests of Cushioned-Meat Racks in Refrigerator-Car Service,[1] by *W. H. Cyr*, Canadian Nat. Railways, Montreal, Que., Canada

Strength Requirements for Special Cars to Transport 40-Ft Trailers, by *H. L. Decker*, The Pennsylvania Railroad Co. (Paper No. 60—WA-263)

The Design and Development of the General Electric FVDL-16 Locomotive Diesel Engine,[1] by *J. C. Rhoads*, Gen. Elec. Co.

SAFETY SESSIONS

1 MONDAY, NOVEMBER 28 9:30 a.m.

Safety and People

Mental Functions and Safety, by *E. V. Crane*, E. W. Bliss Co. (Paper No. 60—WA-189)

Engineering in Resuscitation and Breathing Protection, by *Benjamin Smilg*, Globe Industries, Inc. (Paper No. 60—WA-196)

2 MONDAY, NOVEMBER 28 2:30 p.m.

Panel Discussion: Engineering Industrial Noises

Why Noise is an Engineering Problem,[2] by *F. E. Frazier*, Nat. Assoc. of Mutual Casualty Companies

Noise as a Management Problem,[2] by *J. R. Shaw*, Associated Industries of N. Y. State, Inc.

Evaluating the Noise Exposure,[2] by *H. W. Crouch*, Eastman Kodak Co.

What Management Can Do to Reduce Noise,[2] by *R. L. Young*, Employers Mutual Liability Insurance Co.

Noise as a Consideration in Machine Design,[2] by *A. H. Dall*, Cincinnati Milling Machine Co.

3 TUESDAY, NOVEMBER 29 9:30 a.m.

Jointly With Nuclear Engineering

[1] Paper not available—see box on page 116.

Radioisotopes in Industry—Safety—Part 1

Radioisotope—Breadwinner of Atomic Energy, by *P. C. Aebersold*, U. S. Atomic Energy Commission (Paper No. 60—WA-207)

Health Safety and Regulatory Controls for Radioisotopes, by *J. R. Mason*, U. S. Atomic Energy Commission (Paper No. 60—WA-228)

Atomic Energy Commission Radioisotope Licensing Program, by *Paul Blaetus*, U. S. Atomic Energy Commission (Paper No. 60—WA-206)

4 TUESDAY, NOVEMBER 29 2:30 p.m.

Jointly With Nuclear Engineering

Radioisotopes in Industry—Safety—Part 2

Stimulating New Safe Industrial Uses of Radioisotopes, by *R. E. Black*, Gen. Motors Corp. (Paper No. 60—WA-181)

Security and Radioisotopes,[1] by *R. H. Gallagher*, Liberty Mutual Insurance Co.

5 TUESDAY, NOVEMBER 29 8:00 p.m.

Industrial Ventilation for Safety

How Safe Is Your Design, Installation, and Operation of Industrial Ventilation Systems? by *E. M. Schmidt*, Ford Motor Co. (Paper No. 60—WA-190)

Film: Roof-Ventilation Requirements for Industrial Plants, moderated by *C. W. Crouch*, Gen. Motors Corp.

SOLAR ENERGY SESSIONS

1 WEDNESDAY, NOVEMBER 30 9:30 a.m.

Solar-Energy Steam Generator: Parabolic Cylinder Mirror-Type, by *A. R. Yappel*, Univ. of Arizona (Paper No. 60—WA-89)

Radiant Energy in High-Temperature Research, by *T. S. Laszlo*, AVCO Corp. (Paper No. 60—WA-170)

Energy Balances on a Cylindrical Focusing Solar Collector,[3] by *G. O. G. Lof*, *D. A. Fester*, and *J. A. Duffie*

Progress Report, Solar Energy in 1960, by *J. I. Yellott*, John Yellott Engrg. Associates, Inc. (Paper No. 60—WA-108)

2 WEDNESDAY, NOVEMBER 30 2:30 p.m.

Lightweight Solar-Concentrator Development, by *R. B. Gillette*, *H. E. Snyder*, and *Thomas Timar*, Boeing Airplane Co. (Paper No. 60—WA-90)

Progress in Space Heating With Solar Energy, by *C. D. Engebretson*, Whirlpool Corp., M.I.T.; and *N. G. Ashar*, M.I.T. (Paper No. 60—WA-88)

[2] Not to be printed.

Performance of Silicon Solar Cells at High Levels of Solar Radiation,[3] by *C. Pfeiffer*, *P. Schoffer*, *B. G. Spars*, and *J. A. Duffie*

Performance of a Solar Still,[1] by *Carlos Garrett*, Univ. of Puerto Rico, Mayagüez, P. R., and *E. A. Farber*, Univ. of Florida

WOMEN'S PROGRAM

▶SUNDAY, NOVEMBER 27

2:00 p.m. Registration
4:00 p.m. "Early Bird" Party

▶MONDAY, NOVEMBER 28

8:00 a.m. Registration
8:30 a.m. Coffee Hour
12:15 p.m. President's Luncheon
2:00 p.m. Auxiliary Workshop
8:00 p.m. Japanese Variety Program

▶TUESDAY, NOVEMBER 29

8:00 a.m. Registration
8:30 a.m. Coffee Hour
10:00 a.m. Annual Business Meeting of the Auxiliary
4:00 p.m. Tea Dance
6:30 p.m. Night Club Tour

▶WEDNESDAY, NOVEMBER 30

8:00 a.m. Registration
8:30 a.m. Coffee Hour
8:30 a.m. National Board Breakfast and Meeting
9:30 a.m. Toy Program
12:00 noon Annual Luncheon and Fashion Show
6:30 p.m. Dinner at Leone's
8:00 p.m. Theater—"Sound of Music"

▶THURSDAY, DECEMBER 1

8:00 a.m. Registration
8:30 a.m. Coffee Hour
9:30 a.m. Tour of the Steuben Glass Building
12:00 noon Luncheon at the Luau 400
6:00 p.m. Social Hour
7:00 p.m. Banquet

▶FRIDAY, DECEMBER 2

8:30 a.m. Coffee Hour
9:30 a.m. Tour of the Solomon R. Guggenheim Museum

When the snow starts flying in New York City at approximately 2:00 p.m., Friday, December 2, wouldn't this be an ideal place to be heading for? That's it—the Princess Hotel in Bermuda. A post-Meeting holiday in Bermuda has been arranged by the Society through Embassy Tours. See your advance program for all the details. You travel by air and the price, all-inclusive, is so low you simply cannot afford to miss it.

ASME Power Exposition to Preview Advances in Power-Plant Control

AUTOMATIC intelligence systems for regulating the over-all performance of power plants will be among the outstanding developments exhibited for the first time at the 24th National Exposition of Power and Mechanical Engineering, which is to be held at the New York Coliseum, November 28 to December 2, concurrently with the ASME Winter Annual Meeting.

The biennial Power Show will feature an exceptional variety of new equipment for tying power-plant units into an unbroken stream line to convey energy from the fuel through the combustion and heating processes to the connected power load. The new "sophisticated" control systems, as one exhibitor terms them, are designed to figuratively "take the pulse" of operating units, analyze the individual operations, and regulate controls to secure optimum economy in the over-all operation of the plant.

Performance Monitor. The function of a new "performance monitor," which exemplifies the latest achievements in its line, is to provide engineers with a tool that may help them keep their plants operating at test efficiencies, representing peak economy. It will also aid in scheduling shutdowns economically and may indicate which unit should take the next increment of load. The system has been developed for plants producing steam and/or electric power on a large scale.

Instruments that determine the data that such a robot intelligence system would process will be shown in a number of displays. One of the more advanced lines will include process instrumentation for combustion control, flue-gas analysis, boiler-water analysis, pH indication and control, feedwater analysis, and other data.

Process Instruments. Associated with the comprehensive array of process instruments to be seen at the Exposition will be a number of specialties which have come into the field of automatic controls.

One is a line of tube bundles, or flexible tube harnesses, which provide the nerve systems for automated equipment. Tube bundles may consist of copper or aluminum tubes over which a plastic sheathing has been extruded, or of plastic tubing encased in a taped and armored flexible conduit, similar to an armored electric cable. In the latest improvement polyvinyl tubes are bundled in a specially designed vinyl sheath.

Another line of control specialties consists of miniature air and hydraulic cylinders, push-pull airline couplers, pneumatic valves, and accessories. These units are applied in complete air-control systems and also in automating industrial production machinery.

Communication and Control Systems. Electrical communication and control systems will be exhibited in many forms. Such systems transmit data by signals between sensing and recording units, actuate valves, or control relays in remote locations, and perform many other functions.

One exhibit in this group will include automatic transfer switches—designed to insure continuity of power and light in critical installations—remote control switches for lighting and feeder circuits, as well as program clocks, designed to time or control any electrical function.

In addition to equipment for generating stations, the Exposition will feature equipment for manufacturing plants in many different fields. A line of heavy-duty metering pumps, gravimetric feeders, pressure sensitive instruments, purge meters, and chlorinators covers a wide range of applications. Of leading interest will be a complete materials-handling system, with measuring devices and controls all of one manufacture, for use with dry, free-flowing solids and liquids.

Pumps. A line of heavy-duty triplex pumps will offer such features as total enclosure, integral double-reduction gearing, and the elimination of packing in the high-pressure end. They are designed for pressures up to 20,000 psi, will operate at temperatures from minus 320 F to plus 1000 F, and will handle a range of fluids from water to freon, solvents, and heptane. Pumps of this description are of interest to steel mills, meter fabricators, plastic and rubber molders, and other industries using water for hydraulic power; also for the aircraft, missile, and chemical industries, which require high-pressure pumps for exotic fluids.

Materials. One of the purposes of the Exposition is to provide a review of new design. Many improvements have evolved from the adoption of the latest advances in materials. Plastics and the metals are being rapidly developed and as rapidly adopted by equipment manufacturers.

Much attention has been paid to the use of the right material in the right place, and the variety of specifications available in a single line of equipment signifies the depth of design that has evolved as operating requirements become more critical.

A line of high-pressure, high-temperature bonnetless valves has found many applications in power, nuclear, and missile fields. It has been developed for conditions where absolute tightness through the seat and to the ambient is paramount and its range of applications is indicated by the use of stainless steel, inconel, monel, and titanium as body and trim materials, while designs include globe, gate, extended neck, normalizing fin, bellows seal, and insulating column.

Reflecting the increased demand for high resistance to corrosion, a steel company is bringing out a super stainless steel for resisting hot sulfuric acid. The material is available in pipe, tubing, strip, sheet, plate, and bar and is offered for chemical processing, fabricating, and corrosion control.

For rolling tubes uniformly tight in boilers, condensers, and other heat-transfer equipment a new tube-rolling torque-control instrument will make its first appearance at the Exposition. It is applicable for flared or flared and beaded tubing.

Mechanical Devices. The assortment of mechanical devices for special purposes will include a wide range, from a line of gear-type couplings that may be disengaged while running under load, to lightweight vibration inducers in more than 70 sizes and types. These may be operated by pneumatic, electric, hydraulic, gasoline, or steam power and include a new heavy-duty model that produces a 6600-lb impact. A small redesigned model now weighs only $4\frac{1}{2}$ ounces. It is air driven, safe in explosive atmospheres, and in natural aluminum finish is applicable for handling foods and drugs.

The exposition will be under the management of the International Exposition Company, with permanent headquarters at 480 Lexington Avenue, New York 17, N. Y. E. K. Stevens, president of the company, is manager of the Exposition.

Joint Heat Transfer Conference Grows in Scope and 850 Assemble to Discuss the Gamut From "Hardware

Left to right: D. E. Marlowe, speaker, Jerry McAfee, president AIChE, and A. S. Faust

The Annual Joint Heat Transfer Conference grows in stature with each year since its memorable start at Penn State in 1957. This year, at Buffalo, N. Y., the 12 technical sessions and five panel discussions were held in packed conference rooms, the total registration exceeding 850. Twenty-four builders of heat-transfer equipment displayed their products in the exhibit.

For the record, the Fourth National Heat Transfer Conference and Exhibit, sponsored by the heat-transfer divisions of The American Society of Mechanical Engineers and the American Institute of Chemical Engineers, was held August 14–17, 1960, at the Statler Hilton Hotel in Buffalo, N.Y.

Co-operating with the two societies were the Buffalo Section of ASME and the Western New York Local Section of AIChE. Seventy-two technical papers were presented, 37 contributed by ASME, 35 by AIChE (many heat-transfer engineers are members of both societies). Five panel discussions brought out advanced thinking on subjects ranging from the hardware-minded "Heat-Exchanger Standardization" to far-out "Cryogenic Heat Transfer."

Speaker at the one important social occasion—the "Awards Luncheon"—was Donald E. Marlowe, Vice-President, ASME Region III, and dean of the School of Engineering and Architecture of the Catholic University of America, located in Washington, D. C.

A heat problem solved in some unexplained manner was the temperature at Buffalo. Here was a conference scheduled for mid-August in New York State's second largest city, and the ambient temperature might have been insufferable. Instead, two cold days were conjured up. This is not in Professor McAdams' book. Incidentally, the name Buffalo probably came from the French "Beau Fleuve," meaning "beautiful river."

Technical Sessions

Like the panel discussions, the technical sessions had breadth, from the practical to the academic. If you were brought up on the traditional steady-state heat transfer, you'd find many of the papers bewildering. Not only are today's engineers dealing with the transient state, they are working with nuclear reactors and rocket engines where exceedingly high heat quantities are transferred in comparatively small areas. This focuses attention on boiling as a means of transferring heat at high flux densities.

In recent years, studies of the mechanism of boiling and of boiling heat transfer have led to fruitful developments in the calculation of heat movement. This year, papers went into such phenomena as boiling-at-zero-gravity and boiling at gravities as high as 21 *g*. This, of course, is for rocket applications. Heat must be dissipated from rockets, and boiling offers a possible means of accomplishing this. But the mechanism of boiling depends partly on gravity. What happens when there is no gravity? Or when gravity is multiplied by 20, as in the early acceleration of a rocket?

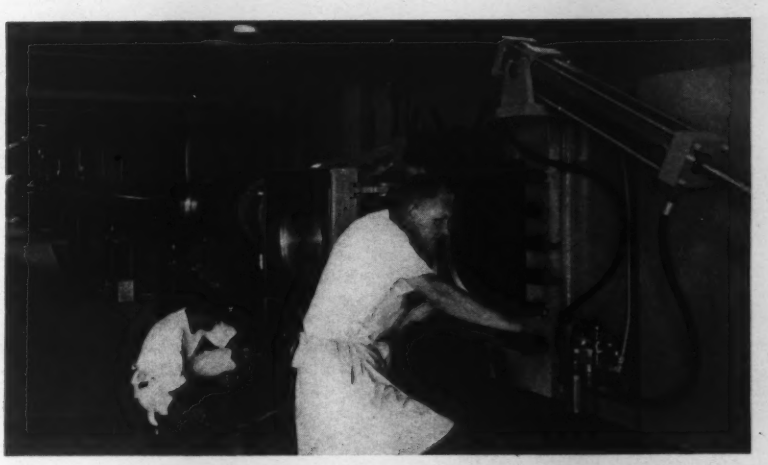
The study of boiling is a tremendous challenge, a field day for physical conjecture and mathematical analysis. Understanding of this phenomenon will not only solve the new and unprecedented problems, but also lead to more compact steam generators. What happens at the surface when small additives are applied to the water? The phrase "at the surface" is vital. That's the mysterious region. To optimize designs, engineers need this information.

A problem that has plagued engineers is the oscillation that sometimes develops in what was supposed to be a natural circulation loop in the cooling of atomic reactors. Suddenly the fluid will set up an oscillation which might uncover the critical heat-transfer area, with catastrophic results. Studies were reported in which the inception and frequency of such oscillations were predicted.

Another line of inquiry concerns the new materials and their thermal conductivity. The Powell method, used years ago, is coming in for refinement and seems to be leading to consistent results.

Solutions are now so often involved with time—the time it takes a heat-transfer situation to develop to the critical point. Such studies in transient heat transfer ran all through the conference papers. Ablation was considered, the loss of metal from a surface (notably in rocket re-entry). The military services are interested in bio-satellite studies, the maintaining of life in a satellite in which temperature is a prime factor.

Attendance—to Science"



At the Cornell Laboratory, the conferees saw this shock tunnel for testing aircraft and missile models at speeds from 6 to 16 times the speed of sound

The study of burnout continues. This is the phenomenon which occurs when heat input is so intense that water ceases to boil, an insulating layer is formed, and turbulent action stops. Heat ceases to transfer, and the metal fails. Today's knowledge is not sufficient to predict burnout to the desired degree.

Panel Sessions

It is in the panel sessions that a conference reaches ahead, bringing out problems that are not yet ready for the technical literature, laying the groundwork for future technical papers. On the first day, the panels covered two extremes, starting with "Heat Transfer in Advanced Nuclear Concepts," then to "Discrepancies Between Design Procedures and Plant Operations." The latter is the type of discussion in which engineers air their differences—in this case, the designers and operators each feel they are at the mercy of the other.

Again, on the second day, we had "Oxide-Fuel Heat Transfer," covering advanced problems in the containment and cooling of atomic fuels, an area in which there is need for operating experience. As before, this was followed by a down-to-earth discussion of heat-exchanger standardization.

The fifth and last panel covered cryogenic heat transfer. The principles of low-temperature heat transfer are the same as any other, except that radiation is less important. Of particular interest are the properties of the materials at these extreme low temperatures.

Wives Hold Secret Session

The women who accompanied their husbands to the conference did not confine their activities to touring Buffalo and Niagara Falls. At their headquarters in the Grover Cleveland Room they held a seminar on "Intelligent Listening and Responding for Engineers' Wives." When an engineer is telling his wife of the latest development in progress at the plant or laboratory, it is important that she say something, now and then. Problem: What to say, and when and how often should she say it? What facial expressions work best? Minutes of this session are "classified," and no photos of facial expressions are available.

Plants in the Buffalo Area

Technical sessions might have been even more crowded but for a series of plant trips that lured men away from Buffalo. On the first day, Alco Products, Inc., invited visitors on an all-day tour of their Dunkirk plant, a major supplier of nuclear-power-plant components and a producer of heavy process equipment for the chemical and petroleum industries. Another tour, offered that afternoon by Hooker Chemical Corporation, included observation of electrolysis of salt brine and the Hooker-developed diaphragm cell used.

That evening, a large group went to the Cornell Aeronautical Research Laboratory, a facility built by Curtiss-Wright during World War II, and later taken under the wing of Cornell University. The tour began with a movie which reviewed many of the unclassified projects the Lab has completed (there are 900 employees, of which 400 are

The Luncheon, with top men of both societies gathered at the head table, Jerry McAfee, president of AIChE, presiding. Mr. McAfee praised the joint conference as the most effective and most desirable type of meeting. D. E. Marlowe, Vice-President of ASME's Region III, spoke on the trend toward unification in the entire engineering profession.

The Annual H-T Exhibit, held in the hotel's new showroom, included booths set up by 24 manufacturers of h-t hardware

engineers and scientists, and last year they did $15 million of business, being self-supporting—and nonprofit). Afterward, the visitors enjoyed a tour of the facilities, including the hypersonic wind tunnel and the "perceptron," a computer that "learns" (it doesn't have an operator; it has a psychologist-trainer).

Other plant trips were: du Pont Electrochemicals Department at Niagara Falls, where heat-transfer equipment is used in all phases of the plant; the Niagara Power Project which, when completed, will be the largest hydroelectric development in the Western world (initial unit scheduled for service Feb. 1, 1961); and the Carborundum Company in Niagara Falls, displaying Carborundum materials pertinent to the subject of heat transfer, especially zirconium.

Awards Luncheon

Jerry McAfee, president of AIChE, presided at the Awards Luncheon. Mr. McAfee expressed his belief that a joint conference, like this one, was the most desirable type of meeting.

Sigmund Kopp of Alco Products, and chairman of the Conference Planning Committee, gave the background of the award that was about to be presented. At the first Joint Heat Transfer Conference, in 1957, it was decided to make an award for the best paper (best in content, not necessarily the best in presentation). Last year, after the meeting at Storrs, Conn., a paper was chosen for this year's award. There were two authors—J. T. Bevans, Space Technology Laboratories, Inc., Los Angeles, Calif., and R. V. Dunkle, Commonwealth of Australia Scientific and Industrial Research Organization, Highett, Victoria, Australia. The paper, entitled "Radiant Interchange Within an Enclosure," was presented at Storrs. This year, Mr. Dunkle was not present to receive his award, and it was accepted for him by Professor G. M. Dusinberre of Penn State, Fellow ASME.

Dr. Marlowe, the main speaker, asserted his belief that there is a trend toward unification in the engineering profession. Among signs that point in this direction are conferences such as this one, and the establishment of unitary engineering courses in which the undergraduate is trained as an engineer, not as a mechanical, chemical, or other specialist. These courses exist now and are increasing in number.

"Engineering education," he said, "will be the liberal-arts education of the future, with specialization handled as in the medical field. We expect doctors to tell us the areas in which they are especially competent, and to send us to other specialists when necessary. One day, it will be like this in engineering."

He reminded his audience that engineering problems no longer come neatly packaged as mechanical or chemical, or any other division, in today's highly developed technology. UCLA has already lumped its mechanical, civil, and chemical-engineering curriculums into one broad engineering course, and Dartmouth and Ohio State will soon follow. Catholic University and others are considering similar consolidations.

"We have organized the engineering profession on a voluntary basis," he said. "The specialties have joined to educate one another, as in this conference. Russia does this, but not on a voluntary basis. Our challenge in the next 20 to 25 years is to show that the voluntary basis is best."

The International Conference

Next year, the conference will be international in scope. Held Aug. 28 to Sept. 1, 1961, at Boulder, Colo., the International Conference on Heat Transfer will include not only the ASME and AIChE, but also their opposite numbers in Britain, The Institution of Mechanical Engineers and the Institution of Chemical Engineers.

Availability List—ASME-AIChE Heat Transfer Conference

THE papers in this list are available in separate copy form until June 1, 1961. Please order only by paper number; otherwise the order will be returned. You can save the postage and handling charges by including your check or money order made payable to ASME with your order and sending both to the ASME Order Department, 29 West 39th Street, New York 18, N. Y. Papers are priced at 50 cents each to members; $1.00 to nonmembers. Payment also may be made by free coupons distributed annually to members, or coupons which may be purchased from the Society. Coupons, in lots of ten, are $4 to members; $8 to nonmembers.

60—HT-1 Wall Temperature and Heat-Flux Measurement in a Round Tube, by A. I. Morgan, Jr., and R. A. Carlson

60—HT-2 Radiative Transport Within an Ablating Body, by L. P. Kadanoff

60—HT-3 Efficiency of Finned Annular Passages, by A. D. Kraus

60—HT-4 Analysis, Results, and Interpretation for Radiation Between Some Simply Arranged Gray Surfaces, by E. M. Sparrow, J. L. Gregg, J. V. Szel, and P. Manos

60—HT-5 Forced-Convection Heat Transfer From an Isothermal Sphere to Water, by G. C. Vliet and G. Leppert

60—HT-6 Temperature Regulation in a Bio-Satellite, by K. L. Cappel

60—HT-7 Heat Transfer to Laminar Flow Across a Flat Plate With a Nonsteady Surface Temperature, by R. D. Cess

60—HT-8 The Effect of Density Variation on Heat Transfer in the Critical Region, by Yih-Yun Hsu and J. M. Smith

60—HT-9 Radiation Heat Transfer in a Spherical Enclosure Containing a Participating, Heat-Generating Gas, by E. M. Sparrow, C. M. Usiskin, and H. A. Hubbard

60—HT-10 An Experimental Study of Boiling in Reduced and Zero Gravity Fields, by C. M. Usiskin and R. Siegel

60—HT-11 Determination of Boiling Film Coefficient for a Heated Horizontal Tube in Water-Saturated Wick Material, by W. D. Allingham and J. A. McEntire

60—HT-12 Radiant Heat-Transfer Analysis of a Furnace or Other Combustion Enclosure, by J. T. Bevans

60—HT-13 Thermal Conductivity and Prandtl Number of Carbon Dioxide and Carbon-Dioxide Air Mixtures at One Atmosphere, by J. L. Novotny and T. F. Irvine, Jr.

60—HT-14 The Influence of Sound on Free Convection From a Horizontal Cylinder, by R. M. Fand and J. Kaye

60—HT-15 Heat Transfer and Pressure Drop in an Annular Gap With Surface Spoilers, by G. A. Kemeny and J. A. Cyphers

60—HT-16 Shell-and-Tube Heat Exchangers: Effect of By-Pass and Clearance Streams on the Main-Stream Temperature, by B. E. Short

60—HT-17 Heat Transfer From Humid Air to Fin and Tube Extended Surface-Cooling Coils, by C. D. Ware and T. H. Hacha

60—HT-18 An Experimental Investigation of the Suitability of JP-4 Fuel for the Regenerative Cooling of a Hypersonic Ramjet Engine, by R. A. Dutton

60—HT-19 An Experimental Study of the Effects of Strong Progressive Sound Fields on Free-Convection Heat Transfer From a Horizontal Cylinder, by A. L. Sprott, J. P. Holman, and F. L. Durand

60—HT-20 Heat Transfer to Water in Turbulent Flow in Internally Heated Annuli: Part 1—Stationary Flow, by Z. Rotem and I Shai

60—HT-21 Heat Transfer to Water in Turbulent Flow in Internally Heated Annuli: Part 2—Pulsating Flow, by I. Shai and Z. Rotem

60—HT-22 Pool Boiling in an Accelerating System, by Herman Merte, Jr., and J. A. Clark

60—HT-23 Heat Transfer by a Turbulently Flowing Fluid-Solids Mixture in a Pipe, by C. L. Tien

60—HT-24 Optimization of a Sandwiched Thermoelectric Device, by B. W. Swanson, E. V. Somers, and R. R. Heikes

60—HT-25 A Survey of P-V-T Data for Water in the Critical Region, by E. S. Nowak, R. J. Grosh, and P. E. Liley

60—HT-26 Smoothed Pressure-Volume-Temperature Data for Water in the Critical Region Derived From Experimental Measurements, by E. S. Nowak, R. J. Grosh, and P. E. Liley

60—HT-27 Hydraulic Instability in a Natural Circulation Loop With Net Steam Generation at 1000 Psia, by S. Levy and E. S. Beckjord

60—HT-28 Two-Phase Slug Flow, by Peter Griffith and G. B. Wallis

60—HT-29 The Viscosity of Steam and Water at Moderate Pressures and Temperatures, by J. R. Moszynski

60—HT-30 Thermal-Conductivity Studies With the Powell Method, by A. I. Dahl and D. W. Jones

60—HT-31 Velocity Distributions, Temperature Distributions, Effectiveness, and Heat Transfer for Air Injected Through a Tangential Slot Into a Turbulent Boundary Layer, by J. P. Hartnett, R. C. Birkebak, and E. R. G. Eckert

60—HT-32 Measured Variations in Local Surface Temperatures in Pool Boiling of Water, by S. T. Hsu and F. W. Schmidt

60—HT-33 Transient Natural Convection From Vertical Elements, by B. Gebhart

60—HT-34 Burnout in Turbulent Flow—A Droplet Diffusion Model, by K. Goldmann, H. Firstenberg, and C. Lombardi

60—HT-35 Film Cooling With Multiple Slots and Louvers, by J. H. Chin, S. C. Skirvin, L. E. Hayes, and F. Burggraf

60—HT-36 Natural-Circulation Tests With Water at 800to 2000 Psia Under Nonboiling, Local Boiling, and Bulk-Boiling Conditions, by O. J. Mendler, A. S. Rathbun, N. E. Van Huff, and A. Weiss

60—HT-37 An Analytical Study of Laminar Film Condensation: Part 1—Flat Plates, by M. Ming Chen

60—HT-38 An Analytical Study of Laminar Film Condensation: Part 2—Single and Multi ple Horizontal Tubes, by M. Ming Chen

First Joint Automatic Control Conference Draws Large Audience

700 Engineers hear report on IFAC conference held in Moscow. Russian interest in automatic control reaches high in Government.

THE American Society of Mechanical Engineers sponsored the first Joint Automatic Control Conference ever held in this country, Sept. 7–9, 1960, at the Kresge Auditorium, The Massachusetts Institute of Technology, Cambridge, Mass. The participating societies were the Institute of Radio Engineers, American Institute of Electrical Engineers, Instrument Society of America, and American Institute of Chemical Engineers. None of the societies which met at Cambridge will conduct any other national conference on control, except as part of their general meetings.

ASME's Boston Section co-operated in sponsoring the conference. The five professional societies came together for discussions on both the technical advances being made in fields of automatic control and the social and economic effects of automation. A total of 57 technical papers was presented at 16 sessions, sessions which overflowed the Kresge Auditorium. More than 700 engineers attended the conference, representing industry, the military, and the colleges, in that order of attendance.

Report on Russia. Some 500 of them attended the evening session, Thursday, Sept. 8, in which a team of outstanding control specialists reported on technical developments observed first hand at the first IFAC (International Federation for Automatic Control) Congress at Moscow. The speakers told the delegates of Russian progress in education, in the theory of automatic control, and in applying controls not just to single machines but to entire factories.

The Automatic Factory. The engineers gathered at this Cambridge conference were a group with an enormous influence on the present and future development of the world's economy. They are the men designing and building tomorrow's automatic factories, control systems for space ships, and automatic power plants —and the electronic brains for tomorrow's automatic offices.

The significance of automatic controls was pointed out by a speaker who said, "In the past we have had machines to replace the manual labor of men. Now we are making machines to replace the brains of men. We are eliminating the slow 'by guess and by God' decisions of men operating huge industrial plants, and substituting the instantaneous decisions of computers and similar devices."

The fact that five engineering societies came together in a conference of this sort illustrates how the field of automatic control cuts across all engineering disciplines. Through a single, joint meeting, the field was covered better and the demand on the time of these specialists was reduced. This tendency toward joint conferences is one of the most significant in the engineering profession today.

The technical papers were of high caliber, and in general they would have to be described as highly technical. Several papers dealt with new devices to permit automatic control of process industries. One described the "gas chromatograph," which automatically measures how much of each chemical is present (in a petroleum refinery, for example), usually taking less than a minute, then feeds information to the computer controlling the plant, which automatically adjusts the plant's operation for maximum output of desired products.

One of the ASME papers took up the design of a roll-stabilization system for a ship, in which underwater fins, like small aircraft wings, develop hydrodynamic life and cause a roll moment that counteracts the ship's roll. This was considered, of course, as a system from the viewpoint of the control engineer.

Russia Aims High. At the evening session which discussed the First IFAC Conference, Harold Chesnut of General Electric, first president of IFAC and chairman of this session, gave the background of the Moscow meeting. It was held June 27 to July 2, 1960, and drew more than 1100 delegates, of which 130 were American. There were technical papers in the areas of theory, components, and applications, with translations into Russian and/or English in each case. Visits to a number of factories, laboratories, and universities were arranged, and Mr. Chesnut could report that he was impressed with the

Panel reports on First IFAC Congress in Moscow, June 27 to July 2, 1960, before a large audience attending Joint Automatic Control Conference. **Left to right** H. Chesnut, chairman; J. G. Truxal, N. B. Nichols, J. O. Hougen, John Gibson, and J. C. Lozier.

desire of the hosts to be hospitable and co-operative.

At Cambridge, speakers seemed to agree that the Soviets are graduating specialists in the field at a much higher rate than the U. S., that they are making "awesome" efforts in control theory, and that they will, within five or ten years, begin construction of automatic factories on a massive scale.

During the discussion period, one of the men who had been in Moscow (30 were present at Cambridge) reported a statement by a Russian, a remark that merits analysis. The Russian said: "Khrushchev said in ten years we will pass you. Nixon said something about 40 years. What's the difference? Eventually we will beat you."

A point worth noting was that all the speakers had been impressed with Russian awareness of the things we were doing in automatic control, as against our own ignorance of what they were doing.

On the last day of the Conference there was a panel session on Automatic Control Education, in which four educators and a representative from industry discussed the role of the university in control engineering. Throughout, there was emphasis on the work of the control engineer in automation. A spokesman said:

"The process of making things automatic is not turned on and off like a water faucet, as Khrushchev is learning to his chagrin. Automatic manufacturing doesn't come by the bushel or ton. It comes through the devoted brainwork and long-range planning of engineers. They design and install the automatic systems which play such an important part in automation. They select the sensing devices, install the communications nerves, perfect the control nerve centers (computers), and match the mechanized muscles to manufacturing machines."

Discussion dealt with university curriculums and university research to serve industry's needs.

At the conference, there were no luncheons or dinners with formal speeches. Aside from the authors' breakfasts, at which authors and chairmen meet, there was only one extracurricular get-together, the "Feedback Dinner," a New England lobster-and-clam buffet.

Next Year. The Instrument Society of America will be the sponsor of 1961's JACC, to be held at the University of Colorado, Boulder, Colo., with ASME, AIEE, IRE, and AIChE participating, as in this year's conference. At Boulder an award will be made, the $100 American Automatic Control Council Award, for the best paper presented at the 1960 JACC.

Availability List—Joint Automatic Control Conference

THE papers in this list are available in separate copy form until July 1, 1961. Please order only by paper number; otherwise the order will be returned. Copies of these papers may be obtained from the ASME Order Department, 29 West 39th Street, New York 18, N. Y. Papers are priced at 50 cents each to members; $1 to nonmembers. Payment may be made by check, U. S. postage stamps, free coupons distributed annually to members, or coupons which may be purchased from the Society. Coupons, in lots of ten, are $4 to members; $8 to nonmembers.

60—JAC-1 Preliminary Design of a Roll-Stabilization System for a Ship, by D. V. Stallard

60—JAC-2 Dynamic Synthesis of Higher-Order, Optimum Saturating Systems, by Fred Kurzweil, Jr.

60—JAC-3 The Optimum Response of Second-Order, Velocity-Controlled Systems With Contactor Control, by Irmgard Flugge-Lotz and Mih Yin

60—JAC-4 Pulse-Width Relay Control in Sampling Systems, by Winston L. Nelson

60—JAC-5 Design of Optimum Multivariable Control Systems, by E. B. Lee

60—JAC-6 Reduction of Dimensionality, Dynamic Programming, and Control Processes, by Richard Bellman and Robert Kalaba

60—JAC-7 Kinetic Lyapunov Function for Stability Analysis of Nonlinear Control Systems, by S. S. L. Chang

60—JAC-8 Improvement of the Power Efficiency of a Hydraulic Control System by the Use of a Gain Compensated Control Valve, by S.-Y. Lee

60—JAC-9 Investigation of Periodic Modes of Sampled-Data Control Systems Containing a Saturating Element, by W. E. Meserve and H. C. Torng

60—JAC-10 Approximate Method for Calculating the Time Response in Linear, Time-Varying, and Nonlinear Automatic Control Systems, by B. Naumov

60—JAC-11 Solution Space Approach to Optimal Control Problems, by Yu-Chi Ho

60—JAC-12 New Results in Linear Filtering and Prediction Theory, by R. E. Kalman and R. S. Bucy

How Well Do You Know Your Society?

So that the members of ASME may know their Society, attention is called to the list of Manuals and Annuals available upon request from the ASME Order Department, 29 West 39th Street, New York 18, N. Y. Unless otherwise noted, all the items in the list will be sent without charge.

AC 2	Annual Report of ASME Research
AC 10	Personnel of Council, Boards, and Committees
AM 1	Membership List—Alphabetical and Geographical (Biennial—odd-numbered years)
AM 3	Catalog of Publications (also included in "Mechanical Catalog")
AM 4	Members List—Listed by Companies (Biennial—even-numbered years, $2 each)
AM 5	Indexes to ASME Papers and Publications
MM 1	Certificate of Incorporation, Constitution, By-Laws, and Rules
MM 2	Know Your Society
MS 4	An ASME Paper (50 cents to nonmembers)
MS 61	Citizenship and Participation in Public Affairs

E. A. Sperry's 100th Anniversary to Be Marked

OCTOBER, 1960, marks the 100th Anniversary of the birth of Elmer Ambrose Sperry, 1928–1929 President of The American Society of Mechanical Engineers, famed throughout the world for his work with gyroscopes, and honored by his colleagues and successors for pioneering achievements in many fields of engineering.

A country boy of 19, in 1879, he built his first dynamo and arc light in his home town of Cortland, N. Y. At 20 he founded in Chicago, Ill., a successful Arc Light Company. During the next 30 years he became one of the most prolific inventors of his time.

Successful companies in such divergent fields as electric-mining machinery, street railways, automobiles, and electrochemistry grew from his inventions.

At 50, when many creative minds have passed their peak, he achieved his most notable success—the application of the gyroscope to navigation and stabilization of ships and planes. Today, in the field of gyroscopics, his name is perpetuated in scores of basic devices for the navigation and control of ships, planes, and missiles.

It is appropriate to note that Dr. Sperry's birth date, October 12, coincides with the date set aside in the United States as a tribute to the explorer, Christopher Columbus. Perhaps only slightly less exciting than the discoveries of Columbus were the discoveries—and their applications—of Elmer A. Sperry, a truly outstanding engineer.

Engineers in the New York area can see an exhibit of Mr. Sperry's early devices developed for land, sea, or air use, which will be held at the Long Island Industry and Science Exposition at Roosevelt Field, Westbury, L. I., from October 8 to 18.

1800 Meet at 12 ASME Regional Student Conferences

DURING April and May of this year some 1800 Student Members of The American Society of Mechanical Engineers journeyed to, or were hosts at, 12 Regional Conferences held in Vermont, New Jersey, Pennsylvania, South Carolina, Ohio, Illinois, Iowa, Idaho and Washington, California, Nebraska, Louisiana, and Colorado.

The large attendance attests to the importance placed on these meetings: Primarily because this is the best way for the Society's youngest members to learn, in a sense, how the national meetings of the Society are conducted and because the students have an opportunity to see for themselves the advantages to be derived from professional society participation. Their major role is emphasized as they present their papers in technical sessions, the inspection trips they take arranged by local industry to manufacturing and research establishments, and by and large their association with fellow students, professors, and leaders in the engineering profession who address their banquets or luncheons.

The programs—as much fun as education—give the visitors something to think about when it is their turn to "run" the show. Without fail, all the Regional meetings closed with a vote of thanks to the host school for the warm welcome and hospitality extended to the visitors, and deep appreciation for the considerate entertainment and assistance they enjoyed.

The Whole Country's Talking. The students give much thought to their place in society and many realize that they can best serve through their professional society. The following excerpts are presented here to illustrate the thinking on a national plane—much is the same, some different, but all considered:

About Student Officers: Student Sections are only as good as the officers in charge. In institutions where the student officers failed to do their share in running the Section, the activity at the college for the year declined.

About Continuity of Student Sections: At Villanova they have a plan that has proved successful. New officers are elected or installed in March or April so that the incoming officers may have a few months to work with the older officers. They schedule day meetings. At Bucknell they have a share-the-offices plan: Senior is president; Junior, vice-president; Sophomore, treasurer; and Freshman, secretary. Another good way they found of generating interest was to organize technical projects for students. At the University of Michigan they elect their secretary and vice-chairman in January and in late May the chairman and treasurer.

About Regional Papers: Interest in regional paper competition has been generated in three different ways including: Technical papers required for class work, local paper contests with cash prizes, and publication of papers in school technical journals.

About Attendance: Wayne State has tried with success a weekly luncheon meeting with a motion picture. While at the University of Michigan, on alternate Wednesdays, they have "all you can eat for 50 cents" luncheons. The topics for discussion are nontechnical and the program often includes a movie. Luncheon meetings, panel discussions, and plant trips have proved to be big attendance attracters.

The Wayne State ASME Student Section has its own meeting room. Coffee is available there at five cents a cup. The profits are used to buy reference books for the ASME room.

Another attendance builder was reported by Pitt and Carnegie Student Sections. They held a joint forum meeting on "What Industry Expects of the Young Engineer." Refreshments were served by the Pittsburgh Section of the Woman's Auxiliary to ASME. The occasion afforded the hostesses an opportunity to tell about their scholarship and loan funds.

There was considerable discussion about co-operation between the Student Section and the Section in the local area. The general consensus was that co-operation existed, but some Sections got much better "report cards" than others—it was reflected in the Student Sections attendance and participation at the Regional meetings, oddly enough.

The new Regional alignment of the Society and what its effect would be on student sections were seriously considered and, last but not least, the term "Promotion from Student Member to Associate Member" met with general approval. The Students agree it is a promotion and not a transfer. This report cannot be closed without this observation: Just like their elders, some like MECHANICAL ENGINEERING; others—well, let's not go into that.

William J. McCrea of M.I.T., right, is congratulated by G. P. Irvine, IBM engineer and one of the judges of Region I, ASME Student Conference, on having received first prize for his paper, "Experimental Vibration Studies and Rubber-Tired Earth Movers." C. H. Coogan, Jr., Vice-President, ASME Region I, looks on.

1960 ASME Regional Student Conference Reports

Region I, New England, University of Vermont, Burlington, Vt., April 22–23, 1960

Attendance: 125 — Papers Presented: 12

Prize	Recipient	Title of Paper	College
First	William J. McCrea	Experimental Vibration Studies and Rubber-Tired Earth Movers	Massachusetts Institute of Technology
Second	Robert D. Moran	How Do Solids Burn?	Tufts University
Third	Philip J. Hamer	The Wankel Engine	University of Vermont
Fourth	James S. Allen	Control of Carbide Distribution in 440C Steel	University of New Hampshire
Old Guard	Robert J. Steffen	Application of Heat Transfer to Cooking	Norwich University

Region II, Eastern, Newark College of Engineering, Newark, N. J., April 23, 1960

Attendance: 108 — Papers Presented: 6

Prize	Recipient	Title of Paper	College
First	Alfred P. Meyer	An Investigation of Plug Nozzles for Rocket Propulsion	Stevens Institute of Technology
Second	Chester A. Engley	Organizational Analysis of Engineering and Design Firms	The Cooper Union
Third	George H. Bloom	A Critical Examination of the Bomb Calorimeter	Pratt Institute
Fourth	George Hazelrigg, Jr.	A Proposed Fuel-Controlled Spark-Ignition Engine	Newark College of Engineering
Old Guard	Alan Schwalb	A Theoretical Analysis on Condensation Limitations and Feasibility of Arc-Heated Hypersonic Wind Tunnels	Polytechnic Institute of Brooklyn—Evening

Region III, Alleghenies, Drexel Institute of Technology, Philadelphia, Pa., April 22–23, 1960

Attendance: 140 — Papers Presented: 16

Prize	Recipient	Title of Paper	College
First	James A. Miller	Material Handling Using Air As a Suspending Medium	Lehigh University
Second	Ian E. Fraser	High-Temperature Metallurgy	University of Rochester
Third	Robert J. Dockery	The Hydrofoil Boat	Catholic University of America
Fourth	J. Carl Pope	Discussion of an Air-to-Air Heat Pump	University of Maryland
Old Guard	Stephen J. Albert	Human Engineering	Union College

Region IV, Southern, University of South Carolina, Columbia, S. C., April 8-9, 1960

Attendance: 164 — Papers Presented: 13

Prize	Recipient	Title of Paper	College
First	David C. Fitch	An Application of Boundary-Layer Control to Axial-Flow Compressors	Mississippi State University
Second	Estal B. Cox	The Wankel Engine	University of Tennessee
Third	Ted L. Lee	The Application of Solar Energy to the Heat Pump	Vanderbilt University
Fourth	Gary W. Dickinson	The Education Challenge—America Versus USSR	Duke University
Old Guard	Robert L. Cowardin	Dynamic Stresses in Railroads	North Carolina State College

Region V, Midwest, The Ohio State University, Columbus, Ohio, April 1–2, 1960

Attendance: 132 — Papers Presented: 12

Prize	Recipient	Title of Paper	College
First	Donald J. Lindley	Pre-College Counselling for Engineers—A National Problem	Ohio State University
Second	Alvin C. Forsythe	The Application and Use of an Anti-Log Field Plotter to Heat Transfer	Ohio Northern University
Third	John M. Hagan	Model Studies in Blast-Furnace Design	Carnegie Institute of Technology
Fourth	Daniel G. Ferguson, Jr.	Steam Power for Automobiles	Michigan State University
Old Guard	Robert J. Barfkbecht	Theory of Corrosion of Underground Structures and Cathodic Protection of Same	Wayne State University

Region VI, Northern Tier, Illinois Institute of Technology, Chicago, Ill., May 6-7, 1960

Attendance: 130 — Papers Presented: 7

Prize	Recipient	Title of Paper	College
First	Robert P. Gerend	Ion Rocket Engine	University of Wisconsin
Second	John A. Milloy	Color Organ	University of North Dakota
Third	Edwin E. Stewart	A Problem of Self-Winding Watches	Iowa State University
Fourth	Roger P. Heinisch	Vortex Flow and Applications	Marquette University
Old Guard	Delvin G. Rapp	Progress Made in Fuel-Cell Development	South Dakota State College

Region VI, Southern Tier, State University of Iowa, Iowa City, Iowa, April 1–2, 1960

Attendance: 138 — Papers Presented: 12

Prize	Recipient	Title of Paper	College
First	Douglas R. Kline	Competition-Fuel Testing on the CFR Engine	Missouri School of Mines & Metallurgy
Second	Jack A. Haines	Design and Construction of a Laboratory Glass-Blowing Lathe	University of Illinois
Third	Norman L. Rundle	Water and Steam Injection in a Gas-Turbine Cycle	University of Kentucky
Fourth	Myron G. Cohn	An Apparatus for Determining the Coefficient of Friction and the Wear of Friction Materials	University of Missouri
Old Guard	Robert R. Piepho	Pressure Transducer Using Hall Generator	Valparaiso University

Region VII, Pacific Northwest, Univ. of Idaho Moscow Idaho; Washington State Univ., Pullman, Wash., April 28-29, 1960

Attendance: 209 Papers Presented: 10

Prize	Recipient	Title of Paper	College
First	Helmut E. Fandrich	Altering the Exhaust Characteristics ot the Two-Stroke Engine	University of British Columbia
Second	Joseph B. Cichocki	Thermoelectric Refrigeration	Washington State University
Third	Frederick C. Guill	Marine Application of Gas Turbines	University of Washington
Fourth	David L. Clements	High-Level Radioactive Waste Disposal	University of Idaho
Old Guard	Richard D. Rice	High-Speed Tire Performance	University of Idaho

Region VII, Pacific Southwest, Stanford University, Stanford, Calif., April 22–23, 1960

Attendance: 106 Papers Presented: 14

Prize	Recipient	Title of Paper	College
First	Joseph W. Lindsey	A Cold Flow Study of Nozzle Feeding in a Four-Nozzle Rocket Case	University of Utah
Second	Paul W. Morgan	Performance of a Multifuel, Low-Smog Spark-Ignition Engine	Stanford University
Third	William E. Layman	Design Considerations for a Low-Gravity Test Facility	Stanford University
Fourth	William L. Pope	Thermal Stresses in a Liquid-Hydrogen Transfer-Line Coupling	University of California
Old Guard	James A. Wooster	Engineering Aspects of Brittle Fracture	California Institute of Technology

Region VIII, Northern Tier, University of Nebraska, Lincoln, Neb., May 2–3, 1960

Attendance: 86 Papers Presented: 12

Prize	Recipient	Title of Paper	College
First	John G. Harri	Attitude Control of Orbital Vehicles	Kansas State University
Second	Robert Henderson	Welded Aluminum—Its Strength and Failure	University of Kansas
Third	Howard R. Kirsch	Absorption Refrigeration for Automobile Air Conditioning—A Preliminary Study	University of Nebraska
Fourth	Ross O. McNary	Plasma Jet Theory and Application	Kansas State University
Old Guard	Richard R. Berns	Electrical Analogy for Members in Torsion	University of Nebraska

Region VIII, Southern Tier, Tulane University, New Orleans, La., April 1–2, 1960

Attendance: 114 Papers Presented: 17

Prize	Recipient	Title of Paper	College
First	Charles F. Stanfield	Electroacoustic Transducers	University of Texas
Second	William D. Bacon	Cushioning of Vehicles for Aerial Delivery Drops	University of Texas
Third	Richard M. Steede	The Viscoelastic Properties of Lubricants	Texas Technological College
Fourth	Ramsey L. Cronfel	The United States and the Technical Assistance Program	Rice University
Old Guard	Robert W. Andres	Investigation Into the Possibilities of Utilizing Exhaust Gas Heat in Air Conditioning an Automobile	Texas Technological College

Region VIII, Rocky Mountain Tier, Colorado State University, Fort Collins, Colo., April 22-23, 1960

Attendance: 313 Papers Presented: 12

Prize	Recipient	Title of Paper	College
First	Edwin W. Sievers, Jr.	A Unique Method of Obtaining a P-V Diagram From an Internal-Combustion Engine	South Dakota School of Mines & Technology
Second	Robert T. Jackson, III	Dresden Nuclear Power Station	University of New Mexico
Third	Howard S. Gudgel	Centennial Rally Computer	Colorado State University
Fourth	William D. Batton	Determining Air-Conditioning Loads by Electric Analogy	University of Colorado
Old Guard	William A. Miller	Ram-Tube Intake Tuning and Exhaust Scavenging of a Four-Stroke Cycle I.C. Engine	University of New Mexico

Other Prizes Presented at the Regional Student Conferences for 1960

1 Two prizes of $25 and $15 were awarded at each Conference to the Student Section having the largest and next largest attendance.

2 Each Conference presents a Man-Mile Trophy to the Student Section who has traveled the greatest number of miles to the Conference. Winners are listed below:

Region	$25	$15	Man-Mile Trophy
I	Norwich University	Northeastern University University of Rhode Island	University of Rhode Island
II	Rutgers University Stevens Institute of Technology		Rutgers University
III	Howard University		Union College
IV	Vanderbilt University	Virginia Polytechnic Institute	Vanderbilt University
V	Ohio Northern University	University of Dayton	Wayne State University
VI-Northern Tier	South Dakota State College	Michigan College of Mining & Technology Sault Ste. Marie Div.	South Dakota State College
VI-Southern Tier	University of Kentucky	Missouri School of Mines & Metallurgy	University of Kentucky
VII-Pacific Northwest	Oregon State College	University of British Columbia	Oregon State College
VII-Pacific Southwest	University of Utah	University of California	University of Utah
VIII-Northern Tier	Kansas State University	University of Oklahoma	University of Oklahoma
VIII-Southern Tier	Texas Technological College	University of Southwestern Louisiana	Texas Technological College
VIII-Rocky Mountain Tier	South Dakota School of Mines	University of Denver	South Dakota School of Mines

Conducted for the National Junior Committee
J.W. FOLLANSBEE

JUNIOR FORUM

Engineers' Unions—An Uncertain Future

By Stewart H. Ross[2]

WITH one third of the employed workers in this country still nonunionized, organized labor's most strenuous current efforts are missionary ones. Largely white-collar workers, these nonunionized employees represent to the labor movement "holdouts" who must be recruited. In this homogeneous group of white-collar workers is a particularly outstanding target of the union's big guns—the engineer.

There are some 750,000 engineers and scientists in industrial employ,[3] and the number grows every year. More significant is the role they play in today's rapidly accelerating technology—and the vital contributions they are certain to make in tomorrow's even more scientifically oriented economy. For on engineers' efforts can hinge the success or a failure of a company. This is no idle platitude, and management willingly acknowledges the importance of the engineer's contribution. Annual reports typically include ". . . . 50 per cent of our sales in 1960 are of products we did not manufacture in 1950."

Organized labor thus eyes the engineer as a lucrative addition to its ranks and a powerful ally. The fact that only 40,000 engineers and scientists (or only 5 per cent) are represented by collective bargaining units[4]—gives impetus to the unions' efforts to draw them into the fold.

The Engineer's Personality. Let us examine the engineer. What does he have in common with other industrial workers, both blue and white-collar? How is he different? An understanding of his likes and dislikes, his goals and aspirations—in short, his personality—may provide valuable clues to the ultimate success or failure of professional unionism.

Probably the one word that best describes the engineer or scientist is "individual." This doesn't mean he is a rebel, or a troublemaker, or even a prima donna. It does mean, generally, that the engineer expects to be treated as an individual—because of his schooling, the conditions that influence his market (currently, and for the past decade, a "seller's market"), and his professional affiliations. His expectations are reinforced when he is told by industry that new ideas are needed—his ideas—and that his advancement will be based solely upon merit and in proportion to his contribution. "Seniority" is an alien term to the engineer; since engineering jobs tend to be unique, and are not reducible to a common denominator by time study, advancement based on seniority basically is contradictory to the engineer's make-up.

The engineer also differs from most 8-to-5 workers who, when they punch out at night, simultaneously file their thoughts about the job. Not so the engineer, whose job often is more "a way of life" than a means to earn a living; he is highly "job-oriented." As a consequence, his job is a greater source of satisfaction (or dissatisfaction) than it is with most workers. Fundamentally too, the engineer is strongly motivated to have his abilities and skills recognized.

Unions are not unaware of these differences. The Industrial Union Department of the AFL-CIO says:[5]

> **"Our discussions and analyses have brought out the fact that one of the problems industrial unions face in meeting the needs of professional and technical workers is that this group wants a kind of professional identification. . . thus, there is the need to take positions on questions of education as they affect scientists and engineers; the need to define professional standards and to deal with the full utilization of the skills of professional workers. . . ."**

Engineering salaries are high compared to the average salaries of industry and government white-collar employees. Based on an Engineers Joint Council survey of 190,000 of its members, the median annual salary of engineers in 1959 was $8750. The National Society of Professional Engineers reported a median annual wage of $10,700, based on a survey of 19,240 of its members. And salaries show an average 6.5 per cent rise each year for the past decade.[6] Engineers rarely are required to punch time clocks; they receive liberal educational benefits; and the road to top management is open to them.

Thus we find that most engineers and scientists have little in common with their co-workers. They enjoy considerably higher salaries; top management sifts their ranks for new supervisory personnel and insures a plentiful supply of trained people by paying the costs of higher education; and their personalities on-the-job, their devotion to their work set them apart from most fellow workers.

Engineer's Evaluation of Unions. How do engineers themselves regard professional unions? Two recent, independent surveys reveal remarkable agreement in engineers' attitudes toward unions. One survey was undertaken by the Bureau of Industrial Relations of the University of Michigan (reported by John W. Reigel in his book "Collective Bargaining as Viewed by Unorganized Engineers and Scientists"). The other was conducted by the trade publication *Machine Design* and was reported in the Dec. 25, 1958, issue.

In the University of Michigan study there were 264 respondents. Of these, 50 per cent were emphatically antiunion and 23 per cent were mildly so. Of the 11.5 per cent with mixed feelings, 6 per cent were slightly antiunion. Thus three-quarters were against. Only 5 per cent were strongly in favor of unions.

Of the 313 nonunionized engineers among those responding to *Machine Design's* survey, 58 per cent were strongly antiunion and 19 per cent were mildly so, for a total of 77 per cent against. Again, 5 per cent were strongly prounion.

Engineers also are disinterested in unions. This attitude was displayed by the minute turnout of engineers to hear a union representative at Pittsfield, Mass., recently. The General Electric Company in this city employs more than 1000 engineers—yet only seven were in the audience to listen to what an organizer for the American Federation of Technical Engineers had to say concerning the advantages of collective bargaining for professional employees.

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[1] Designer, Voorhees, Walker, Smith, Smith & Haines, New York, N. Y. Assoc. Mem. ASME.

[2] Assoc. Mem. ASME.

[3] *Fortune*, May, 1960, p. 248.

[4] *White Collar Report*, Jan. 12, 1960, p. 7.

[5] *White Collar Report*, May 11, 1959, p. 2.

[6] *Industrial Relations News*, Aug. 1, 1959.

History and Present Status of Engineers' Unions. Yet, some engineers do join unions—to bargain collectively with their employers. Although not common knowledge, engineers' unions have existed in this country since 1919. The major growth occurred after World War II, however, when great numbers of engineers from the campus and government service were attracted into private industry. Under the Wagner Act (as interpreted by the National Labor Relations Board) industrial unions then could absorb engineers into blue-collar bargaining units. To prevent this amalgamation, regarded by the professional engineering societies and company management alike as being highly undesirable, engineers established their own small, independent unions. Originally these bargaining units were not at all militant. Their members conceived of these units solely as instruments for educating management about engineers' somewhat different problems.

Of the 40,000 engineers represented by unions today, 20,000 are dues-paying members. There are 10,500 members affiliated with the Engineers and Scientists of America, the only national federation of engineers in this country and the biggest professional union. About 7500 engineers are in AFL-CIO bargaining units. The figure of 20,000 dues payers has remained the same for the past five years, despite an increase in the number of engineers.

Although engineering bargaining units, particularly those which have affiliated with the AFL-CIO and the Engineers and Scientists of America, have grown somewhat more aggressive in their demands on management, in general they still emphasize "professional" rather than "economic" objectives. This is made clear by the recently negotiated contract with the engineers' union at the Boeing Airplane Company in Seattle, Wash., and Wichita, Kan.[7] Among the most important gains claimed by the union in this contract were the right of its members to wear different color identification badges and the right of engineers to sign drawings. The present title block, which provides space only for Drawn By and Checked By, is a relic of the time when all drafting was performed by engineers . . . . the change (the addition of a line for the responsible engineer's name) emphasizes the different function and different responsibility of the engineer relative to the draftsman, the union says.

Professional Society Opposition. Aside from the individual engineer's own opposition or indifference to unions, there are well-financed antiunion pressures being exerted. The professional societies which represent engineers vociferously attack unions and principles of unionism. The most outspoken organization of this kind is the National Society of Professional Engineers. NSPE boasts 52,000 state-licensed members in a nationwide organization of semiautonomous state functional societies. Its theme: Professionalism and unionism are absolutely irreconcilable. NSPE has come forth with what is almost a Magna Carta on the conflict. This declaration,[8] entitled "Professional Responsibility vs. Collective Bargaining," is as follows:

1 Collective bargaining for professional engineers is in conflict with the basic principles of a professional individual.

2 The individual responsibility and independent judgment required of a professional engineer is incompatible with the regimentation inherent in unionization.

3 Collective bargaining divides members of the profession into hostile groups and promotes discord among members of the same profession.

4 Constructive relations between professional engineers and management and the full development of professional engineers can best be accomplished through programs in co-operation with all elements of the engineering profession.

5 More than 20 years of experience demonstrate conclusively that the individual engineer and the engineering profession are best served through reliance upon the professional concept of solidarity in service to the public welfare—and avoidance of collective bargaining.

NSPE adds deeds to words by arranging campus meetings to discredit professional unions in the eyes of neophyte engineers. Apparently encouraged by union criticism ("violent antiunion propaganda poisoning the minds of engineering students"), the society plans to step up these efforts.[9] NSPE also strongly opposes unionization of technicians since this "could hinder the professional engineer in his professional activities" and might force the engineer himself into unions. NSPE concludes that unionization has a leveling effect on salaries; unions by their nature are hostile to management, and engineers must work closely with management; and seniority cannot be used as a basis for engineer promotions.

As an alternative to the growth of unions it dreads, NSPE advocates formation of "sounding board" groups, which can serve as nonbargaining units of engineers, including those in management, to improve communication between professional engineering employees and management. Sixteen such groups (12 within the General Electric Company)

[7] *White Collar Review*, June 7, 1959, p. 3.

[8] *White Collar Review*, Sept. 12, 1959, p. 8.

[9] *Ibid.*, Feb. 23, 1959, p. 2.

Preview of Junior Session at 1960 ASME Winter Annual Meeting

The National Junior Committee will conduct its Junior Session at the 1960 ASME Winter Annual Meeting in New York. The session will be held on Wednesday, November 30, at 8:00 p.m.

The theme will be "Professional Aid for the Young Engineer." The speakers include:

John Gammel, Affiliate ASME director of Graduate Training, Allis-Chalmers Manufacturing Company, Milwaukee, Wis. Mr. Gammell is chairman of the Training Committee of ECPD and will speak on the session theme.

Albert Underwood, Jr., acting manufacturing manager of Ford Motor Company, Ltd., Windsor, Ont., Canada. Mr. Underwood, who has been active in professional societies, will speak from experience on "How Participation in Professional Activities Can Aid the Young Engineer."

Richard A. North, Mem. ASME, Chairman of the Old Guard, will speak about Old Guard activities in connection with the young engineer.

William M. Morley, Assoc. Mem. ASME, of the Stock Equipment Company, Cleveland, Ohio, will speak on "Benefits I Derived From ASME." He is the past-chairman of the National Junior Committee.

Norman J. Viehmann, Assoc. Mem. ASME, product-planning engineer, Western Electric Company, North Andover, Mass., will round out the session with a brief talk. He is chairman of NJC this year.

After the scheduled talks, the floor will be opened to the audience. The only ground rules: Conduct yourself as a professional and be recognized by the Session Chairman Bob Heinzman of Therm, Inc., Ithaca, N. Y.

This promises to be a most interesting and informative session for both young and older engineers.

Albert S. Goldstein
Meetings Subcommittee

exist today. NSPE hopes to see this approach become a trend.

Affected companies also engage in strong attacks on engineering unionism. The most current example is that of the Western Electric Company, where 6575 engineers voted last May to determine representation in a union—the Council of Western Electric Professional Employees-National, the nation's second-largest engineering union. In literature, mailed to the homes of its engineers, Western Electric denounced the Union—"by its very nature an impediment to technical progress and a detriment to individual members," and, according to the Union, spent $5 million on its antiunion campaign. The tally: 3972 against, 2603 for.

NSPE hailed the less-than-conclusive vote as "additional confirmation that the industrially employed engineer of today prefers a professional approach toward engineer-management relations, rather than that offered to him by unions." Earlier, NSPE had claimed: "If the Union loses, it will virtually spell the end of engineers' unions in the country."

Advantages of Union Membership. Organized labor counters professional society-management harangues by pointing out that it recognizes the differences between professional and blue-collar unions and that unionization need not have a leveling effect on salaries. Contracts should have provisions for merit increases to be negotiated between the individual engineer and his supervisor.

Also, unions do not have to be hostile toward management; particularly among professional employees, the employee-employer relationship must not be antagonistic. Unions further claim that a certified group, recognized by management as such, is much more effective than the sounding-board organization because it establishes a legal definition of "professional" for membership in the group. It can make demands which employers are required, by law, to sit down and consider. Unions also argue that they do not intend to apply seniority as a basis for promotions or pay increases for engineers. But seniority could be reserved as a possible factor in equitably determining lay-off procedures.

Unions point out further that the engineer's current favored status in the eyes of management will change when the engineering shortage is eased, and he will be just an ordinary employee. Even now, the unions claim that engineers are gradually losing their sought-after professional status and prerogatives.

And finally, the unions emphasize that, after all, engineers really have the same desires as any other labor group, albeit that their "personality" is different, and that they must pay the same prices for goods and services. The obviously increased bargaining power engineers gain by union membership can be the vehicle for increased professional stature and recognition.

The Problem of "Professionalism." But if engineering unionism is to succeed, the professionalism problem must be solved. The conflict over "what is an engineer" already has taken its toll of the once-powerful Engineers and Scientists of America. (In 1956 ESA comprised 14 affiliated engineering unions, with 25,000 dues-paying members, and representation rights for 43,000. Four years later, directly as a result of internal conflict over professionalism, ESA is tottering. Membership is at an all-time low of 10,500.) Unlike the physician or attorney who must have an advanced degree from an accredited university to practice plus certification by state board examiners that he is indeed qualified to practice, the "engineer" who works in industry often has no engineering degree nor is registered in his state. Only engineers whose work directly affects the health, safety, and welfare of the state's residents are required by law to be certified a Professional Engineer—and proportionately few engineers hold positions of such responsibility. Engineers who are registered, however, look with disdain at unregistered engineers; engineers with engineering degrees scorn "engineers" who hold no degree; and technicians who hold responsible engineering positions snub engineering-fringe technicians. These social-status differences carry over to the formal organization, and engineers do not want to join unions that include technicians and draftsmen as bona fide members.

The controversy resolved by vote at Western Electric illustrates the internal schism arising out of this professionalism question. The Western Electric union was negotiating its fourth contract when a disagreement arose with the company on the meaning of "engineer." The union insisted on an organization composed solely of engineers. It wanted no technician or draftsmen members, refused to bargain for them, and demanded that the company accept the union definition of a professional engineer. Western Electric categorically stated that anyone doing professional work was therefore a professional. And the National Labor Relations Board concurred that work performed, not the individual's qualifications, is the controlling factor.

Another problem confronting the unions is that they cannot hope to court the engineer successfully until they can find organizers who can speak his language. For, while the factory hand who becomes a union staffer usually gains in income and prestige, the engineer who becomes an organizer is likely to lose status among his peers—and income as well.[10]

It appears then that the cards are stacked heavily against the spread of engineering unionism. Survey results point to an overwhelming rejection of professional unions by the potential members of the bargaining units. Union recruitment efforts, stymied at the outset by the difficulty of obtaining spokesmen who can speak the engineer's language, are vigorously resisted by organized professional society—company management programs. And the unresolved professionalism problem is a disuniting factor in the already-formed professional unions. It can be concluded that so long as engineers feel they are not being exploited—and today engineers not only are not exploited, they are hotly pursued and romanced—they will not join unions.

[10] *Fortune*, May, 1960, p. 248

ASME COMING EVENTS

October 9-12
ASME Rubber and Plastics Conference, Lawrence Hotel, Erie, Pa.

October 17-19
ASME-ASLE Lubrication Conference, Statler Hilton Hotel, Boston, Mass.

October 24-25
ASME-AIME Fuels Conference, Daniel Boone Hotel, Charleston, W. Va.

November 27-December 2
ASME Winter Annual Meeting, Statler Hilton Hotel, New York, N. Y.

March 5-9, 1961
ASME Gas Turbine Power Conference and Exhibit, Shoreham Hotel, Washington, D.C.

March 12-16, 1961
ASME Aviation Conference, Statler Hilton Hotel, Los Angeles, Calif.

March 16-17, 1961

ASME Textile Engineering Conference, Clemson College, Clemson, S.C.

April 6-7, 1961

ASME-SAM Management Engineering Conference, Statler Hilton Hotel, New York, N.Y.

April 9-13, 1961

ASME Oil and Gas Power Conference and Exhibit, Jung Hotel, New Orleans, La.

April 10-11, 1961

ASME Maintenance and Plant Engineering Conference, Bancroft Hotel, Worcester, Mass.

April 23-26, 1961

ASME Metals Engineering Conference, Penn-Sheraton Hotel, Pittsburgh, Pa.

May 7-10, 1961

ASME-EIC Hydraulic Conference, Queen Elizabeth Hotel, Montreal, Que., Canada

May 10-12, 1961

ASME Production Engineering Conference, Royal York Hotel, Toronto, Ont., Canada

May 22-25, 1961

ASME Design Engineering Conference and Exhibit, Cobo Hall, Detroit, Mich.

June 11-15, 1961

ASME Summer Annual Meeting, Statler Hilton Hotel, Los Angeles, Calif.

June 14-16, 1961

ASME Applied Mechanics Conference, Illinois Institute of Technology, Chicago, Ill.

August 28-September 1, 1961

Second International Heat-Transfer Conference, University of Colorado, Boulder, Colo.

September 14-15, 1961

ASME-AIEE Engineering Management Conference, Hotel Roosevelt, New York, N. Y.

September 24-27, 1961

ASME Petroleum Mechanical Engineering Conference, Muehlebach Hotel, Kansas City Mo.

October 4-6, 1961

ASME Process Industries Conference, Shamrock Hilton Hotel, Houston, Texas

October 17-19, 1961

ASME-ASLE Lubrication Conference, Morrison Hotel, Chicago, Ill.

November 26-December 1, 1961

ASME Winter Annual Meeting, Statler Hilton Hotel, New York, N. Y.

(For Meetings of Other Societies, see page 109.)

Note: Persons wishing to prepare a paper for presentation at ASME National meetings or Division conferences should secure a copy of Manual MS-4, "An ASME Paper," by writing to the ASME Order Department, 29 West 39th Street, New York 18, N. Y. Price to nonmembers, 50 cents; to ASME members, free.

CANDIDATES FOR MEMBERSHIP AND TRANSFER IN ASME

THE application of each of the candidates listed below is to be voted on after Oct. 25, 1960, provided no objection thereto is made before that date and provided satisfactory replies have been received from the required number of references. Any member who has either comments or objections should write to the Secretary of The American Society of Mechanical Engineers immediately.

New Applications and Transfers

Alabama

CAVENY, LEONARD H., Huntsville
MURPHREE, KENNETH E., Sheffield

Arizona

●MACDOUGALL, ERNEST A., Warren
●WOODRUFF, WILLIAM N., Phoenix

California

●COWELL, WILLIAM D., Concord
DALTON, DICK N., FPO San Francisco
DIETHER, PHILIP A., Los Altos
FRIEDMAN, HENRY, Los Angeles
GUALDONI, TITO E., Los Angeles
●GUINS, VSEVOLOD G., Palo Alto
HELKEY, LAWRENCE G., Los Angeles
KURZ, FRANK, San Francisco
OSBORNE, HAROLD A., San Pedro
OSBURN, NEILD H., Pasadena
●PORTER, JAMES A., Long Beach
PREBLE, J. CHARLES, North Hollywood
ROSENBERG, JEROME C., Reseda
SHEPHERD, WILBURN O., Whittier
SHORT, JAMES H., Los Angeles
●WEINER, FREDERICK R., Canoga Park
YASTE, MERLIN D., San Jose

Connecticut

DUFFY, DONALD, Groton
●HOPE, HERBERT W., Bridgeport
●KENTNOR, CHARLES B., JR., Fairfield
LAWRENCE, KURT, Groton

Delaware

●IRWIN, HOWARD D., Wilmington
●SWANSON, JARL R., JR., Wilmington

District of Columbia

KOBAYASHI, FRANCIS M., Washington

●Transfer to Member or Affiliate

Florida

●DIXON, ROBERT R., St. Petersburg
●LUFF, HARRY C., JR., Orlando
●STEINLEN, ADOLPH L., Tampa
●THOMAS, JACK L., Riviera Beach

Illinois

DAL COROBBO, PETER V., Chicago
DAVISON, SAMUEL M., JR., Evanston
●ERKERT, HERBERT A., Peoria
●HERTLEIN, CLYDE D., Arlington Heights
RADWILL, ROBERT P., Chicago
RASSOOL, FADHIL A., Chicago
ROBERTSON, REED S., Chicago
●STORCH, DANA H., Wilmette
●WERTHEIMER, MILTON A., Rock Island

Indiana

MCJONES, ROBERT W., Columbus

Iowa

STUBSTAD, WILLIAM R., Cedar Rapids

Kansas

●SLIEF, FORREST A., Wichita

Kentucky

●METKE, ROBERT GEORGE, Paducah
●SCHOLES, MED HOOPER, JR., Paducah

Louisiana

●MADDUX, RAYMOND P., New Orleans

Maryland

●EDMISTON, JAMES M., Glen Burnie
TYRRELL, HENRY G. K., Baltimore

Massachusetts

BADALA, VINCENT J., Walpole
●LALIKOS, JAMES M., Springfield
●LIEBMANN, SEYMOUR W., Framingham
●MALMBERG, PHILIP O., Weston
●MAY, DANIEL H., JR., Boston
SADLOW, JOSEPH F., North Reading
SIGURDSON, STEPHEN, Beverly
STENNING, ALAN H., Cambridge

Michigan

BLAISDELL, JOHN L., East Lansing
●GABRIEL, MARTIN G., Dearborn
●JOHNSON, DAVID R., Niles
●MITCHELL, MELVIN R., Midland
STARKWEATHER, JOHN D., Northville

Missouri

REMINGTON, CHARLES R., JR., Rolla

New Hampshire

BLACKWOOD, FRANK A., Portsmouth

New Jersey

●EATON, EDGAR P., JR., Morristown
FITCH, JOHN G., Whippany
●GITTERMAN, HENRY, Teaneck
LACASSE, JOSEPH T., Haddonfield
PEARCE, RONALD H., Point Pleasant
●TANG, THOMAS C., Princeton

New Mexico

LENERT, GILBERT B., Albuquerque

New York

●ALTMANN, HEINZ C., Rochester
●COX, GEORGE B., JR., Schenectady
●DUROCHER, JOSEPH D., JR., New York
●FROST, GEORGE C., South Glens Falls
●GOODMAN, THOMAS P., Schenectady
GREENWOOD, HAROLD, Webster
●KELEHER, HENRY W., Binghamton
KERR, ARNOLD D., New York
●KNOWLES, DANIEL H., Corning
LIPSCHUTZ, LEWIS D., Poughkeepsie
LOWE, IRA E., Yonkers
MASTERSON, FRANK H., Poughkeepsie
●MOORE, CHARLES V., Schenectady
●MUELLER, WHEELER K., New York
PENTLAND, WILLIAM, Ithaca
SCHROEDER, PHILIP, Jackson Heights
SEABURY, WILLIAM A., 3RD, Ulster Park
●SEELY, JOHN H., Poughkeepsie
TAYLOR, ROBERT B., Burnt Hills
●VOJNOVIC, STEVAN N., Corning

North Carolina

BOOE, BRANTLEY C., JR., Winston-Salem
BREEZE, MARVIN M., JR., Winston-Salem
HALL, ROBERT H., Winston-Salem
PENDLETON, GLENN B., Winston-Salem
POFFENBERGER, PLINY S., Advance
●STEVENS, ALFONSE A., Raleigh
WHITE, GEORGE S., Winston-Salem

North Dakota

●RITCHIE, WARREN L., Minot AFB

Ohio

ATTIG, RICHARD C., Alliance
●GOVIN, CHARLES T., Salem
HORNE, JOHN MCNULTY, Mt. Vernon
●JACKSON, FRANCIS W., Cincinnati

JANSSEN, KENT E., Alliance
MENDELSON, ALEXANDER, Cleveland
●RALSTON, EDWARD L., Alliance
WALDRON, WARREN D., Northfield
●WEISEND, BURKE A., Cleveland

Pennsylvania

●BARR, VICTOR LEO, Philadelphia
●BRADLEY, GUY D., Erie
BRITTON, JAMES A., Philadelphia
DAVIS, SOL, Philadelphia
LARSEN, BURTON A., Erie
LODY, TIBOR D., Allentown
●SACK, THOMAS F., Scranton
OSTERLE, WILLIAM H., Greensburg
●SEELINGER, RICHARD W., Erie
STOCK, ROBERT JOSEPH, Philadelphia
●WEISS, ALBERT, Pittsburgh

South Carolina

●FREEMAN, GEORGE B., Williston
HART, PHILIP G., Hartsville
PATTERSON, JAMES B., Hartsville

Tennessee

●PERKINS, CHARLES H., Knoxville

Texas

●ABADIE, VICTOR H., JR., Houston
CALVERT, THOMAS C., Dallas
●CARAMEROS, ALEXANDER H., El Paso
COLLINS, ORELL, Beaumont
●COX, ROLAND O., Dallas
●DEVENY, CHARLES A., JR., Baytown
FOREMAN, HILLIARD S., Port Arthur
FULCHER, CLAY W. G., Tyler
GRAY, JOHN T., Beaumont
GUINN, DAVID C., Houston
RYAN, PAUL V., Houston
●VACLAVIK, CHARLES E., Houston
●WILLIAMS, CURTIS D., Dallas
WOOLRICH, WILLIS R., JR., Houston

Virginia

●DEDDENS, JAMES C., Lynchburg
●ESLEECK, SAMUEL H., Lynchburg
FULTON, MINITREE S., Newport News

Washington

●STAAB, WARREN J., Brookfield
●MILLER, GEORGE, Richland

West Virginia

LICCHILLO, ARTHUR C., Clarksburg
OLIVETO, TONY J., Clarksburg

Foreign

BRAUN, CANTILO EDWARDO, Buenos Aires, Argentina
DOWNING, CLIFFORD NORVIC, Toronto, Ont., Canada
JOHNSTONE, WILLIAM WATSON, Melbourne, Australia
KRAIRIKSH, BHALLOBH, Bangkok, Thailand
MOWAT, ALFRED W., Toronto, Ont., Canada
●PUCCI, MIGUEL ANGEL, Mexico, D.F., Mexico
ROBINSON, HECTOR WILLMOTTE, Liguaner, Jamaica, W. I.
SINGH, CHARANJIT, Saskatoon, Canada
WHITNEY, ROY, Poynton, Cheshire, England

ENGINEERING SOCIETIES PERSONNEL SERVICE, INC
[Agency]

THESE items are listings of the Engineering Societies Personnel Service, Inc. This Service, which co-operates with the national societies of Civil, Electrical, Mechanical, and Mining, Metallurgical and Petroleum Engineers, is available to all engineers, members or nonmembers, and is run on a nonprofit basis.

If you are interested in any of these listings, and are not registered, you may apply by letter or résumé and mail to the office nearest your place of residence, with the understanding that should you secure a position as a result of these listings you will pay the regular employment fee of 60 per cent of the first month's salary if a nonmember, or 50 per cent if a member. Also, that you will agree to sign our placement-fee agreement which will be mailed to you immediately, by our office, after receiving your application. In sending applications be sure to list the key and job number.

When making application for a position include eight cents in stamps for forwarding application to the employer and for returning when possible.

NEW YORK 8 West 40 St. | CHICAGO 29 East Madison St. | SAN FRANCISCO 57 Post St.

Men Available

Chicago Office

Project Manager, Engineering Manager, BSAcE, BSME; 38; 12 years' responsible project supervision in liaison and operational engineering in aircraft and automotive gas-turbine and rocket-engine-propulsion devices in R&D with prototype components. $14,000, minimum. Midwest. Me-1162-Chicago.

Design and Product Development, BSME; 28; two years' shop and manufacturing experience in heavy machinery; familiar with modern production machines, methods, and relative costs of production on various machine tools. $7500. Midwest. Me-1163-Chicago.

Chief Industrial Engineer, BSME; 37; initiated incentive standards, made methods improvements, reduced work force, and maintained sales volume for a profit improvement of $200,000 in one year. $10,000–$12,000. Location optional. Me-1164-Chicago.

Plant Engineer, BSME; 39; several years' experience on new construction, expansion, modernization, and maintenance of varied manufacturing facilities in the capacity of plant and project engineer. $9600. Midwest. Me-1165-Chicago.

Product or Marketing Manager, BSME; 40; 18 years' marketing, merchandising experience in fabricated metals including over-all product responsibility; specification selling to consultants, owners, through representatives, branch offices; direct negotiation, special equipment to Government and systems contractors; distributor sales; OEM automotive sales; aircraft power-plant installation and service experience. $18,000–$20,000. East or Midwest. Me-1166-Chicago.

Engineer or Manager, BSME; 41; 13 years' experience in all phases of chemical-plant design, start-up, and operation. Particularly qualified in field of agrochemical plants producing ammonia, nitric acid, and urea. Desires challenging position in engineering design or plant operation. $11,000. Any location including foreign. Me-1167-Chicago.

Chief Engineer, MSME; 41; 18 years' experience in design, research, and new product development including six years' administrative experience as supervisor and chief engineer, heavy machinery, hydraulics, and internal-combustion engines. $16,000–$18,000 a year. Location open. Me-1168-Chicago.

Research and Development Engineer, BSME, Purdue, 1954; 27; data-reduction group leader concerned with preparation of aircraft engine and component test data for engineering reports, through use of analog and digital equipment; also designed test equipment and conducted tests on aircraft engines and military vehicles. $7800. Anywhere in U. S. Me-1169-Chicago.

Chief Engineer, Manager of Engineering, or **Plant Manager;** BSCE, Univ. of Kansas, 1950; 33; four years chief engineer and plant manager, appliance manufacturing; two years senior product engineer, air-conditioning manufacturing; now product-development manager, same firm; one year chief product engineer, wiregoods manufacturing. $15,000, plus. No preference as to location. Me-1170-Chicago.

Chief Draftsman, graduate mechanical engineer; 54; 25 years' experience in all phases product engineering including design, development, and administration. Good record in full, successful conclusions on engineering projects. Open. Upper Midwest. Me-1171-Chicago.

Plant Manager or Production Superintendent, BSME; 47; 23 years' experience as layout man, foreman, production superintendent, and plant manager in fabrication, erection of steel and alloy process equipment for chemical refinery, distillery industries. Supervised all crafts, programming, cost control, labor relations, plant layout, and maintenance. $10,000–$12,000. Prefers U. S. including Hawaii, or South America. Me-1172-Chicago.

New York Office

Chief Manufacturing Engineer, Higher National Certificate Mechanical Engineering; 15 years' experience in design, development, manufacturing, and production. Products include ordnance, aircraft engines, television, telephonic communication, etc. $10,000. West, Midwest. Me-866.

Machine-Development Engineer, BSME; eight years' experience as design engineer; two years as machine-development engineer. $10,000. Northeastern U. S. Me-867.

Chief or Consulting Engineer, BSME and BA; broad background in design, development, manufacture, application, and patenting of fine mechanical and electrical products. Special experience in customer contact, organization, analysis of products and troubles. $15,000. Philadelphia or East. Me-868.

Applications or Sales Engineer, BSME, Univ. of Maryland; two years' experience as design and liaison engineer mechanisms design, air-conditioning design, structural design with aircraft manufacturer. $6000–$7200 a year. East or West Coast. Me-869.

Engineer, BME, Cornell Univ., 1942; 18 years' experience as chief engineer and supervisory work in Cuban sugar mills. Design, operation, maintenance, new projects, improvements, labor relations, and budget planning. At least $10,000. Prefer; South Calif. Me-870.

Development Consultant, PhD; 34; American and European background; machine and electronics industry; practice in manufacture, design, R&D, administration; seeks international assignments. Me-871.

Supervisory Industrial Engineer, BSIE; Nine years' experience in heavy and light industry, machining and fabrication. Strong in mechanical engineering and production, advanced training for cost controls and administration. $10,000. East. Me-872.

Senior Project Engineer, BMEPE, N. Y. and N. J.; 11 years' broad experience in hydraulic and pneumatic systems, components. Strong in valves, regulating devices, flows and high pressure, and elevated temperatures. $12,000. Northern N. J. or New York Metropolitan area. Me-873.

Contracts Administrator or Project Manager, Plant Engineer; 41; over 20 years' engineering experience with strong mechanical background. Thoroughly competent in contracts administration and office management. Recently completed six years in Europe as contracts manager at SAC airbase complex as prime contractor's representative. Very good Spanish. Prefers Europe, Latin America, or Western U. S. Salary open. Me-874.

Plant Manager, Works Manager, or Project Manager, BSME; 20 years' engineering, manufacturing, and management experience in the electromechanical and electronic fields. Successful in all phases. Can take over plant or supervise (or co-ordinate) engineering and manufacturing. $10,000. Will relocate. Any in U.S. Me-875.

San Francisco Office

Industrial Engineer, ME, 31; five years' experience in manufacturing industry and construction. Method and time studies, plant layout, cost control, design of jigs and fixtures. $8000. Prefers San Francisco area or Pacific Northwest. Home: Ore. Se-1737.

[1] All men listed hold some form of ASME membership.

Mechanical Design, 57; 25 years' industrial-design shop experience. Metal-fabricating plant designs. Chemical and mining processing floor by floor layout. Field experience. $9000. Prefers Northern Calif. Home: Calif. Se-1716.

Design Analyst, ME, 25; one year design and design studies for aircraft company; two years' maintenance field work with Thor Missile, Army. $7500. Prefers West Coast or Foreign. Home: N. Dak. Se-1706.

Sales Engineer, Estimator, 37; eight years' experience selling sheet-metal items, building materials, to contractors, architects, engineers. Five years' experience estimating for general contractors on dams, powerhouses, warehouses, manufacturing plants, commercial buildings, apartment houses, homes; also surveying supervision of excavation, concrete work, timber framing, supervision of all trades and jobs. $7200–$12,000. Prefers San Francisco Bay area. Home: Bay area. Se-1696.

Designer, ME, 36; six years' experience design of heating, ventilating, air conditioning, plumbing for installations in buildings; also industrial furnaces. $6300. Prefers San Francisco Bay area. Home: East Bay. Se-1680.

Sales Engineer, Estimator, 43; 17 years' experience in sale of steel buildings, building materials, and also estimating on general construction; self-employed and for contractors. $9000. Prefers San Francisco Bay area. Home: Marin County. Se-1673.

Plant Engineer, ME(Canada), 38; 15 years' experience including set-up departments, procedures, budgets, train engineers, new construction, layouts, design, purchasing, cost control, material co-ordinator, economic evaluation and market research for chemical companies, engineers, constructors. $10,500. Prefers West Coast, Any. Home: Texas. Se-1672.

Maintenance Superintendent, Plant Engineer, ME, 39; three years Allis-Chalmers, mining and milling machinery; three years in charge of maintenance 34,000 TPD concentrating plant (copper) including redesign and installation new machinery, ordering and stocking all spares and materials, organization and scheduling of maintenance work, direction of engineering for cost reduction. Also six years design and development special mechanisms. $12,000. Prefers western U. S. or South America. Home: Calif. Se-1669.

Production, Sales, 46; over 20 years' experience production of small gas and diesel engines, transmissions, tool, die, design, administration for machine shops; also charge of sales and service for small cars. Five years machinist for railroads. $7500. Prefers San Francisco Bay area, Calif. Home: San Francisco. Se-1649.

Laboratory Chief, Design, MS MachE (Hungary), 57; Seven years' charge of laboratory research, development, surpervise staff for electric and machinery factories. One year charge of design for power plants; 25 years supervise technician and sales activities for electric machinery factory (Hungary). $10,000. Prefers Southwest. Home: East. Se-1627.

Research, Design, Development, ME, 28; one year design, development, and production of prototype high-pressure ground support compressor system for missiles. Two years teacher and research assistant, mechanical and machine design. Salary open. Prefers West. Home: Ind. Se-1623.

Junior Mechanical Engineer, ME, 30; recent graduate, desires any type of mechanical work including piping, designing, manufacturing. $4800. Prefers San Francisco Bay area. Home: San Francisco. Se-1621.

Plant or Production Manager, 36. Experienced in all phases of contract manufacturing, plant layout. Estimating, quality control, production control, purchasing, tool and fixture, design for printed circuit and electronic package assembly, electronic sheet-metal fabrication, and assembly. $7800–8400. Prefers San Francisco Peninsula. Home: Calif. Se-1587.

Production-Metal Working, ME, 23; one year layout design, of tire molds, rubber extruding dies, and dynamic, static test wheels. Also practical experience as machine operator in job shop. Salary open. Any location. Home: San Francisco. Se-1580.

Manufacturing Engineer, IE, IndMgmt, 26; four years' experience including methods engineer, time studies, studied facilities layout for aircraft and auto assembly. $7500. Prefers San Francisco Peninsula. Home: Calif. Se-1571.

Manufacturing Management, Operation Research, ME and CE, 51; 30 years' experience including forwarding planning for facilities,

Keep Your ASME Records Up to Date

The ASME Secretary's Office depends on a master membership file to maintain contact with individual members. This file is referred to countless times every day as a source of information important to the Society and to the members involved. All other Society records are kept up to date by incorporating in them changes made in the master file.

The master file also indicates the Professional Divisions in which members have expressed an interest. Many Divisions issue newsletters, notices of conferences or meetings, and other material. You may express an interest in the Divisions (no more than three) from which you wish to receive any such information which might be published.

Your membership card includes key letters, below the designation of your grade of membership and year of election, which indicate the Divisions in which you have expressed an interest. Consult the form on this page for the Divisions to which these letters pertain. If you should wish to change the Divisions you have previously indicated, please so notify the Secretary.

It is highly important to you and to the Society to be certain that our master file indicates your current mailing address, business or professional-affiliation address, and interests in up to three Professional Divisions.

Please complete the form, being sure to check whether you wish mail sent to your residence or office address, and mail it to ASME, 29 West 39th Street, New York 18, New York.

Please Print

ASME Master-File Information

Date

LAST NAME _____ FIRST NAME _____ MIDDLE NAME _____

POSITION TITLE _____ NATURE OF WORK DONE _____

e.g., Design Engineer, Supt. of Construction, Manager in Charge of Sales, etc.

NAME OF EMPLOYER (Give name in full) _____ Division, if any _____

*☐

EMPLOYER'S ADDRESS _____ City _____ Zone _____ State _____

ACTIVITY, PRODUCT, or SERVICE OF EMPLOYER; e.g., Turbine Mfrs., Management Consultants, Oil Refinery Contractors, Mfr's. Representative, etc.

*☐

HOME ADDRESS _____ City _____ Zone _____ State _____

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PRIOR HOME ADDRESS _____ City _____ Zone _____ State _____

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Address changes effective when received prior to:

I subscribe to

☐ MECHANICAL ENGINEERING	10th of preceding month
☐ *Journal of Engineering for Power*	20th of preceding month
☐ *Journal of Engineering for Industry*	
☐ *Journal of Heat Transfer*	
☐ *Journal of Basic Engineering*	
☐ *Journal of Applied Mechanics*	
☐ *Applied Mechanics Reviews*	1st of preceding month

Professional Divisions in which I am interested (no more than *three*) are marked X.

☐ A—Aviation	☐ J—Metals Engineering	☐ S—Power
☐ B—Applied Mechanics	☐ K—Heat Transfer	☐ T—Textile
☐ C—Management	☐ L—Process Industries	☐ U—Maintenance and Plant Engineering
☐ D—Materials Handling	☐ M—Production Engineering	☐ V—Gas Turbine Power
☐ E—Oil and Gas Power	☐ N—Machine Design	☐ W—Wood Industries
☐ F—Fuels	☐ O—Lubrication	☐ Y—Rubber and Plastics
☐ G—Safety	☐ P—Petroleum	☐ Z—Instruments and Regulators
☐ H—Hydraulics	☐ Q—Nuclear Engineering	
☐ I—Human Factors Group	☐ R—Railroad	

equipment, systems and budgets, cost-control systems, plant conversions and modernizations, mergers and tax-loss revisions; also manage commercial and industrial construction. $12,000. Prefers San Francisco Bay area. Home: Mich. Se-1570.

Design, Development, ME, 34; eight years' experience, research, development, design of mechanical equipment, tools, dies, fixtures, oil-well equipment, for consultants, oil companies, and research institutions. $10,000. Any location. Home: Southwest. Se-1547.

Positions Available

Chicago Office

Product R&D Engineer, graduate mechanical, industrial, or architectural, several years' experience in product design. Should be able to contribute creative ideas in the development of windows, doors, hardware, and allied buildings products and be willing to assume responsibility in the design department. Good possibility for right man to assume management of product development for a manufacturer. $10,000, plus, depending on experience. Iowa. C-8275.

Assistant Professor, Mechanical Engineer, PhD required. At assistant-professor level will teach mechanical-engineering subjects. Consulting, R&D work is permissible and is available at extra compensation. $9200 on a 12-month basis. C-8245.

Chief Product Engineer, graduate mechanical, to 50; full responsibility for all phases of engineering design. Product design of voting machines together with related R&D functions. Direct activities of R&D, product engineering, and experimental sections and work closely with manufacturing and sales department. Responsible for administering long-range R&D projects. Responsible for patent protection and operation of department, $200,000 budget. Background in office machinery, aircraft, automotive or appliance field desirable. Familiar with stamped and machined components and final product having a high degree of reliability. Aptitude for complex mechanical motions involving medium-precision parts necessary. Experience in electrical or electronics a requirement. Open. Pa. C-8244.

New York Office

Reseach Engineers. (a) Applied mechanics, MSME, applied mechanics or physics, five to eight years' experience for work consisting of concept and exploratory studies of new and advanced components for automated machine tools and electronic inspection devices. $10,000–$15,000. (b) System design, BSME, three to eight years' experience, for work consisting of design of new automated machine tools and electronic inspection devices and research test fixtures. Experience in development of machine tools helpful. $8000–$13,000 a year. Company pays fees. New England. W-9533.

Methods Engineer on process fabricated machined and sheet-metal parts for electronic assemblies and process and plan tooling for such assemblies. Experience should include two to three years' experience in machine-shop practice, plus three or more years of electronic assembly experience, in addition to electronic assembly methods experience. $7000–$9000. New England. W-9528 (b).

Standards Engineer, mechanical or industrial-engineering graduate, to supervise standards and specifications in engineering department; knowledge of electrical-electronic components and experience setting up and running engineering-standards program. $9000–$11,000. Ohio. W-9520.

Design Engineer, mechanical graduate, preferably with MS and five years' design and development experience on rotating machines including stress analysis and vibration studies on shafts, bearings, and seals. Must be U. S. citzen. $8000–$10,000 a year. N. J. W-9516.

Sales Engineers, either recent graduate engineers in mechanical engineering with major in field of refrigeration and air conditioning or those with experience in the industry for several years. Positions principally of application of accessory items to refrigerated equipment of all sizes. Practical on-the-job training program after which applicants will be sent to other areas. Salary plus commission bonus arrangement plus all expenses. Company pays fees. Mo. W-9515.

Maintenance Engineer, graduate mechanical, about ten years' experience in the field of maintenance in the chemical industry. Salary open; extensive company-paid benefits. N. J. W-9506.

Chief Engineer for an automatic screw machine plant, at least ten years' experience on automatic screw machines and secondary operations, including machine set-up work plus substantial experience on drafting board. Should have some supervisory experience. Will supervise operation layout and design of tools, fixtures and jigs, and gages for job-shop work on Brown and Sharpe and New Britain and Acme Multiple Spindle Screw machines. $9000–$10,000 a year. Company pays fee; assistance given on moving expenses. Conn. W-9498.

Additional listings of positions and men available are maintained in the offices of E.S.P.S. Direct inquiries to nearest office. A weekly bulletin of engineering positions open is available at a subscription rate of $4.50 per quarter or $14 per annum, payable in advance.

Chief Manufacturing Engineer, engineering degree, at least ten years' heavy industry experience in tooling, processing, routing, time study and methods, and considerable standards and incentives in foundry and heavy machining. $10,000–$12,000 a year. Mass. W-9488(a).

R&D Engineer, mechanical graduate, preferably with advanced degree, capacity for creative accomplishment. Should have technical background, interest, and determination to advance professionally as a proved inventor of specialty steam equipment and related products. Must have sound theoretical knowledge in the field of thermodynamics and related engineering subjects. Excellent opportunity. Salary and profit-sharing bonus participation commensurate with experience. Eastern Pa. W-9482.

Design Engineer, BS in mechanical or chemical engineering, and at least five years' experience in chemical, petrochemical, or cryogenic process-equipment design, to design cryogenic plant equipment such as distillation columns, heat exchangers, gas scrubbers, and piping to satisfy process-cycle conditions in the production of oxygen, nitrogen, argon, and hydrogen. Travel about 15 per cent. $9000–$11,400. New York, N.Y. W-9481.

Plant Manager, mechanical or electrical graduate, at least 5 years' managerial experience and full responsibility for R&D, product engineering, production, application, and customer liaison for military and industrial electronic components. $18,000–$20,000 a year. New England. W-9478.

Assistant or Associate Professor of Industrial Engineering, MS degree with further advanced study desirable. Primary needs are in fields of metal processing, automation, plant layout, methods engineering, work measurement, and industrial organization. Opportunity to teach advanced courses and a graduate program leading to MSIE is under development. Time available for research. New England. W-9477.

Engineers. (a) Chief engineer, mechanical or electrical graduate, at least ten years' supervisory experience covering design and development of aircraft indicating instruments and navigation equipment for commercial and military service. $25,000. (b) Chief manufacturing engineer, mechanical or industrial-engineering graduate, at least eight years' supervisory product engineering, production planning, methods, etc., covering precision instruments. $15,000. New York City area. W-9473.

Engineers. (a) Senior industrial engineer, engineering degree and four to five years' diversified industrial-engineering experience at a fairly senior level, probably with small company. Will report directly to manager of industrial engineering. Not particularly interested in office systems procedures and cost analysis, etc. $8000–$10,000. (b) Plant engineers, engineering degree with air-conditioning and refrigeration-maintenance experience, for preventive maintenance and new construction. About $10,000. Upstate N. Y. W-9470.

Mechanical Engineer, graduate, five years' experience, preferably in the cup-making field; the alternative being experience with paper-converting machinery. Will be responsible for plant and equipment maintenance; major improvements, plant layout, material flow, securing or designing new machinery for intended product line, and installation of this machinery. $8000–$10,000. South. W-9466.

Senior Industrial Engineer and Cost Accountant, wide domestic and foreign experience in industrial areas covering manufacturing, agriculture, and mining, to analyze and appraise enterprises covering marketing, production, and cost accounting. Open. Duration, at least two years. Mediterranean area. F-9463.

Centrifuge Engineers, graduate mechanical or chemical, ten to 12 years' experience with process equipment for responsible positions in: (a) Technical co-ordination; three to five years' technical experience with centrifuges required. Knowledge of German; reasonable freedom to travel. Will work closely with testing, production, sales, and customers on engineering and related matters. (b) Sales co-ordination; three to five years' experience in selling centrifuges to industry; administrative ability; reasonable freedom to travel required. Will work with salesmen on major customer calls, provide training in selling and product applications, do related administrative assignments. Company may negotiate fee. Headquarters, upstate N. Y. W-9447.

San Francisco Office

Design, Office Engineer, ME; well qualified by recent experience to carry out duties of application engineering from board work, preparing estimates and specifications, to supervise contractors' installation. On air-condition equipment and refrigeration, largely military installations. U. S. citizenship required. Will train briefly in New York headquarters and then be transported to Guam. Housing available. Three-year contract for long-established manufacturer's distributor. $7800–$10,200, depending on experience. Southwest Pacific. Sj-5493.

Production Trainee, ME or ChE, 28–35, qualified by academic or recent working experience to participate in training program involving paper-mill activities. Lead to promotional work in production divisions of large manufacturer; or to transfer to other producing division in South America, Germany, or Italy. Duties are demanding and hours may be on shift basis. Salary commensurate with experience. Los Angeles. Sj-5489.

Management Trainee, ME or IE, young, some work experience relating to production control in printing, cutting, and supervision of skilled and unskilled operators. Should be qualified by academic training and experience to rapidly assume duties of assistant to plant manager and ultimately move to plant manager. For manufacturer of folding cartons. Salary commensurate with experience. Los Angeles or Seattle. Sj-5490.

Industrial Engineer, IE, 28–35. Minimum three to four years' industrial engineering related to production problems and work simplification in paper-board plants. About $7200. San Francisco East Bay. Sj-5488.

Designer, ME; minimum of three years' specific experience in inertial controls field, good knowledge of precision instrumentation including transistor systems, gyro experience desirable; capable of handling small controls or inertial stabilizers type. Will assist chief engineer in development of mechanical system and should be able to do required board work along with some development requiring original thinking. For a manufacturer. U. S. citizen. $9000–$14,000. San Francisco Peninsula. Sj-5452.

Design, Office Engineer, Registered ME in Calif., 30–45, experience in design, preparation of drawings, estimate and writing of specifications for air conditioning, ventilation, plumbing and process piping for industrial and commercial buildings and military projects. $9000–$12,000. Southern California. Apply by letter. For consulting engineers. Sj-5459.

Designer, engineering degree, preferably ME, at least five years' experience in paper and paper-board manufacturing, however, rather than pulp manufacturer. Thoroughly familiarly with and be able to perform economic studies and reports; cost estimates; paper machine and related equipment design; flowsheets; process control and instrumentation. Salary open. Pacific Northwest. Sj-5457.

Instrument Engineer, Ch, EE, or ME, five years' experience in refinery and chemical plant instrumentation. Experience in nuclear reactor instrumentation advantageous, to engineer systems and write specifications for basic instruments, control systems, safety interlocks, and relief systems for refineries, chemical plants, and nuclear reactors. $7500–$10,200. U. S. citizen. Southern Calif. Sj-5455.

Designers, ME, to assist in development of mechanical systems and able to do required board work along with some development requiring original thinking for program and development of series of proprietary devices, mainly in field of unique and high-performance servo-mechanical transducers; including closed-loop accelerometer acceleration switches; single and double-integrating accelerometers, pressure and pressure-ratio devices. $8000–$9000. San Francisco Peninsula. Sj-5452.

Product Analyst, EE or ME, minimum two years' experience product design engineering preferably in logical or circuitry or systems of business machinery. Able to write reports, prepare and maintain details of functions and engineered specifications for production and development, provide engineering interpretation of specifications to engineering personnel, conduct studies and report on functional characteristics of competitive equipment. For business machine manufacturer. U. S. citizen. About $8400. San Francisco East Bay. Sj-5544.

Safety Engineer, ME or other, 30–40, qualified by experience to make field investigations, survey physical characteristics, recognize hazards,

review record, meet with safety committees, evaluate and sell safety recommendations, and make public talks concerning safety; for insurance company. $6300 for trainees; $7200 for some experience. Car required. San Francisco headquarters. Sj-5543.

Marketing Assistant, ME background, preferably with BusAdm, under 30. Two to three years' experience in mechanical systems, particularly those related to involved mechanisms, controls, and drives. Must have indicated aptitude for customer contact and flair for marketing approach (advertising, promotional material, catalogues, dealing with representative), on equipment related to launching devices, accelerators, and other complete major mechanical systems, including hydraulics controls and mechanisms. Possibly missiles and satellite arrangements. For system development and manufacturer. To $7500. San Francisco East Bay. Sj-5539.

Production Engineer, ME or equivalent, 35–50. Well qualified by recent experience to provide engineering assistance on quality control, production operations, work simplification, and improvement on highly mechanized machinery for cold rolling, slitting, and forming aluminum sheet. Also enameling or other coating of aluminum. Will report to plant manager for metal-fabricating shop. Largely metal treating. $9000–$10,200. Marin County. Sj-5530.

Designer, ME, 30–35, five to ten years' experience. Career opportunity in power-plant design for electric-utility company. Rapid expansion program. Married preferred. $8400–$9600. Pacific Islands. Sj-5529.

OBITUARIES

Armand William Benoit (1883–1960), associate and treasurer, Chas. T. Main, Inc., Boston, Mass., died May 15, 1960. Born, Lawrence, Mass., August 17, 1883. Education, BS, Tufts College, 1907. Mr. Benoit specialized in industrial engineering. He was in charge of construction work on filter beds and pumping stations while working with William Wheeler, hydraulic and sanitary engineer of Boston, from 1907 to 1909. He joined Chas. T. Main, Inc., as a resident engineer on construction work in 1909, and remained with the company until his death, having become a member of the firm in 1919. He designed manufacturing buildings and powerhouses of textile plants, and organized textile-plant machinery, particularly in woolen mills. He became an assistant engineer in 1919. He authored several technical papers on industrial plants, cost accounting, and other phases of the textile industry. Mem. ASME, 1921. He was a past-chairman of the Executive Committee, Textile Division, ASME. He was a registered professional engineer in the State of Rhode Island, and a member of the Boston Society of Civil Engineers. He is survived by his wife.

Ward Follet Davidson (1890–1960), retired director of research for the Consolidated Edison Co. of New York, died July 12, 1960. Born, Commonwealth, Wis., Oct. 21, 1890. Father, Otto C. Davidson. Education, BSE, Univ. of Michigan, 1913; MS, 1920. Married Elizabeth Bostwick, 1917; children, Ward F. Jr., and Elizabeth Sargent. Mr. Davidson was a pioneer in the study of air pollution and smoke control. In 1956, he received the Frank A. Chambers Award from the Air Pollution Control Asssociation for his work in the field. He is credited with making the first scientific analysis of soot fall-out in New York City. An electrical and mechanical engineer, Mr. Davidson also was an expert on power, including nuclear power. In 1950 he was a delegate to the World Conference on Atomic Power in London. After graduating from the Univ. of Michigan, he taught electrical engineering there intermittently until 1922, also spending several years in active duty during World War I as a captain in the Army Corps of Engineers, in England, France, and Germany. From 1922 to 1937 he was director of engineering investigation at Brooklyn Edison Co., organizing research work first in the electrical-engineering department and then in the executive department. His work included investigations of stoker fuel beds, development of improved methods for dust sampling in stack gases, and studies of metallurgical problems in high-temperature piping, and heat transfer through boiler tubing. He went to Consolidated Edison as director of research when it absorbed the Brooklyn company. In World War II he was a consultant to the National Defense Research Committee and to the Smaller War Plants Committee. For his services he received the Presidential Certificate of Merit. Becoming active in the nuclear power field, Mr. Davidson prepared papers in 1947 and 1949 for the World Power Conference at The Hague on peacetime uses of atomic energy. He retired in 1955. He was the author of numerous technical papers, some of them on nuclear power, and was awarded several patents relating to electrical cable systems. Mem. ASME, 1927; Fellow ASME, 1941. He served the Society as member, ASME Committee on Complete Power Plants. He was a member of AIEE, AAAS, ASTM, and NELA; an associate fellow of the Institute of the Aeronautical Sciences, a member of the American Physical Society; and a member of The Institution of Mechanical Engineers, and the Institution of Electrical Engineers, both of London. He was a member at large of the Division of Engineering and Industrial Research, National Research Council. Member, also, IRE, American Chemical Society, American Meteorological Society, American Geophysical Union, Tau Beta Pi, and the Illuminating Engineering Society. He was a registered professional engineer in the State of New York. Surviving are his wife; a son, Ward F., Jr., of Tucson, Ariz; a daughter, Mrs. Ralph Smith-Johannsen of Port Washington; and four grandchildren.

Edward Andrew Deeds (1872–1960), retired chairman of the board, National Cash Register Co., Dayton, Ohio, died June 30, 1960. Born, Granville, Ohio, March 12, 1872. Parents, Charles and Susan (Green) Deeds. Education, BS, Denison Univ., 1897; attended Cornell Univ. Married Edith Walton, 1900 (dec. 1949); children, Edward Jr. (dec.), and Charles Walton. An inventor, industrialist, and financier, Col. Deeds—he was commissioned in the Army in the first world war—held many prominent positions during his lifetime. He began life as a poor Ohio farm boy, but advanced to the offices of chairman of the board of Pratt & Whitney (aircraft engines), and Niles-Bement-Pond (electrical machinery); as well as president of the National Sugar Co., a combination of 100 Cuban sugar firms; and vice-president of the National City Bank of New York. He was a director of 30 of the country's major industrial and business enterprises. He exhibited early engineering enterprise when, in order to work his way through Denison University, he operated the school lighting plant and the village electrical plant and water works. He also served as janitor of the science building. He began his career as assistant draftsman for The Thresher Electric Co., Dayton, Ohio, and rose within a year to be chief engineer and superintendent. He resigned in 1900 to become construction and maintenance engineer for the National Cash Register Co. While there he designed and built the powerhouse, and electrified the plant, resigning after two years to go to Niagara Falls where, as chief engineer, he designed the plant and equipment (including the automatic electric baking machines) of the Shredded Wheat Co. He was in charge of plant operation for a time, but then returned to the National Cash Register Co. as vice-president in charge of engineering and production. At that time, he brought into the company the late C. F. Kettering, Fellow ASME, then a struggling young Ohio engineer. Together the two men created several new industries through the years. Col. Deeds is credited with conceiving the idea of electrifying cash registers. He directed the establishment of company plants in England, France, Germany, Austria, Italy, and Canada. When he resigned from the company again in 1914, he was vice-president and general manager. Col. Deeds worked with his friend Kettering in developing the electric starting, lighting, and ignition system for automobiles, a device that created a new industry and resulted in the establishment of the Dayton Engineering Laboratories Co. (Delco). The two men sold this business in 1916 to General Motors Corp. for several millions of dollars, and devoted themselves to The Domestic Engineering Co., an industry created by them for the manufacture of isolated house lighting outfits. They sold this company to General Motors in 1919. Col. Deeds was president of the organization, and president as well of The Smith Gas Engineering Co., builders of clean gas producers. Col. Deeds was made a member of the Ohio Flood Relief Committee in 1913. In April, 1917, he became a civilian member of the Munitions Standards Board, then a member of the Aircraft Production Board, and later was placed in charge of the Production Division of the board's activities. In August of that year he was commissioned a colonel in the regular army. He was largely responsible for the broad foundation upon which the aircraft-production program proceeded, and for the development and production of the Liberty engine, America's first war-produced airplane engine. Indicative of his determined business methods is the story of the invention of this mass-produceable engine. As director of aircraft procurement, Col. Deeds locked two inventors, J. G. Vincent and E. J. Hall, into a Washington Hotel room, releasing them only after they had produced a workable design, a task they completed in three days. In the depression year of 1931, when National Cash Register profits had dwindled, Col. Deeds went back to the company as chairman of the board, and from 1936 to 1940 was president as well. He retired as chairman of the board in 1957 at the age of 83 and was named honorary chairman. Affiliate ASME, 1900. He also was a member of AIEE, the Institute of the Aeronautical Sciences, the Society of Automotive Engineers, and the Engineers' Club of New York. He was a charter member of the American Electrochemical Society, a president of the Engineers' Club of Dayton, and a trustee of Denison University. He is survived by a son, Charles W. Deeds of Farmington, Conn., three grandchildren, and four great-grandchildren.

Herbert Laurand DeLaune (1902–1960), structural engineer, Thiokol Chemical Corp., Marshal, Texas, died June 20, 1960. Born, Gramercy, La., March 13, 1902. Parents, Jules C. and Martha (Richarme) DeLaune. Education, ME, ICS, 1933. Married Wilma Frey, 1930. Mr. DeLaune was a draftsman, and later an assistant chief engineer with the Mexican Petroleum Corp. of Louisiana, in Destrehan, La., for several years beginning in 1922. He also worked with the Pan American Refining Corp. His work included calibrating gage tables for barges, oil tanks, tank cars, and other containers. He also was in charge of orifice and recording meters, and worked with service units such as steam-power plants, electric power systems, and water and air-compressor systems. From 1927 to 1928 he worked with the Louisiana Highway Bridge Dept. He was assistant chief engineer and assistant production superintendent with the Silas Mason Co., Shreveport, La., from 1941 to 1944. In 1944 he joined the J. B. Beaird Co., Inc., Shreveport, La., as a superintendent in the pressure-vessel department. He specialized in the manufacture of pressure vessels, bubble towers, and other vessels to meet the ASME code, and supervised the manufacture of a 105-mm shell line. Mr. DeLaune later went with Thiokol Chemical Corp, where he was a structural engineer at the time of his death. Assoc-Mem. ASME, 1934; Mem. ASME, 1937. He was a member of the Texas Society of Professional Engineers and the National Society of Professional Engineers. He was a registered structural engineer in the State of Texas.

Lawrence Sarafield Dowling (1914–1960), methods engineer, Diehl Mfg. Co., Finderne, N. J., died May 31, 1960. Born, New York, N. Y., June 19, 1914. Education, BS(ME), Newark College of Engineering, 1956. Mr. Dowling worked with the design of tools, fixtures, gages, and molds, calculating the most economical method of manufacturing fractional and integral hp motors, fans, saws, resolvers, and so forth. He also worked with cost records and supervised the correlation of production machines being set up for new orders. Assoc. Mem. ASME, 1956. Survived by wife, Beatrice; and two daughters.

Joseph W. Eshelman (1893–1960), owner, Joseph W. Eshelman and Co., Inc., Birmingham, Ala., died, July 11, 1960. Born, Greencastle, Pa., Jan. 31, 1893. Parents, Abraham Lincoln and Anna (Melkas) Eshelman. Education, graduate, Pennsylvania State Teachers College, Shippensburg, Pa., 1911. Married Jimmie Ross, 1895; child, Joseph W. Jr. Mr. Eshelman spent a year with the Railway Mail Service after graduation, and, in 1912, was employed in the engineering department of the Bell Telephone Company of Pennsylvania. The next several years were spent in Wyoming and Oregon, where he was associated with one of the large banks in connection with its mining and lumbering interests. He was a service engineer on combustion apparatus for the Jos. W. Hays Corp., Michigan City, Ind., 1914–1918; a sales engineer located in Chicago, New York, and Pittsburgh territories for the Republic Flow Meters Co., Chicago, until 1920; and a southern manager in charge of sales in the South East for the same company, 1920–1925. His work concerned the sales and application of steam flowmeters, water meters, gas meters, pressure gages, and carbon-dioxide and draft instruments. In 1925 he helped establish Neville, Eshelman and Cleary, a sales-engineering business in Birmingham, correlated with the engineering work of the previously listed equipment. He was vice-president and later president of the company, which came to be known as Eshelman and Potter, and finally as Joseph W. Eshelman and Co., Inc. From 1926 he was a sales representative for several companies, primarily with products in the power field. He also worked with the Air Preheater Corp., New York, N. Y., on sales and engineering of heat recovery apparatus in central stations and industrial plants. As manager of the Southern office of the Combustion Engineering Corp. in New York, he sold and serviced steam-generating equipment, fuel-burning apparatus, and general power-plant auxiliary equip-

ment. Assoc-Mem. ASME, 1926; Mem. ASME, 1939. He was vice-president of ASME from 1942 to 1944. He served as chairman of the Birmingham Section of ASME, and was Local Sections' delegate for two years. He also was a member of Association of Iron and Steel Engineers and Birmingham Engineers Club, and a registered professional engineer in the State of Alabama.

Elmer Kirkpatrick Hiles (1871–1960), retired mechanical engineer, died, Pittsburgh, Pa., Feb. 23, 1960. Born, Chicago, Ill., Aug. 8, 1871. Father, Albert Hiles. Education, BS-(ME), Univ. of Illinois, 1895. Married Sarah E. Donovan, 1926. Mr. Hiles specialized in gas engines. He gained his early experience with several firms, including C. A. Hiles and Co., Chicago, where he served his apprenticeship; Ball and Wood Co., Elizabeth, N. J., where he gained shop experience and became an erecting engineer; and Westinghouse, Church, Kerr and Co., powerhouse installation. He also was an assistant engineer and chief draftsman with Osborne Pipe Line System. With Chas. E. Sargent, from 1901 to 1903, he helped to develop commercially the Sargent gas engine. During his early career he was engaged also in designing a 3500-hp blowing gas engine, and had charge of designing and installing large gas-engine plants with Westinghouse Machine Co. He became a chief engineer in 1906, designing and constructing gas engines with Struthers-Wells Co. During World War I, he was a lieutenant-colonel, engineers, 15th Engineers' Corp. He served ASME for 60 years. Assoc. Mem. ASME, 1900; Mem. ASME, 1906. He is survived by his wife, the former Sarah E. Donavan.

Bradley S. Johnson (1874–1960), sales engineer, W. H. Miner, Inc., Chicago, Ill., died May 12, 1960. Born, North View, Va., Feb. 2, 1874. Education, BS, Virginia Polytechnic Inst.; ME, 1900. Mr. Johnson began his career 60 years ago as a mechanical inspector on steel-car construction for the Pressed Steel Car Co., Pittsburgh, Pa. He spent his early years with several other steel and railway-specialty companies, including Bessemer and Lake Erie Railroad headquarters, Greenville, Pa.; with the Levelman Engineering Corps.; Robert W. Hunt and Co., New York and Pittsburgh; Farlow Draft Gear Co., Baltimore, Md.; and T. H. Symington Co., Chicago, Ill. At various times he had charge of steel-structure construction, railway-car construction, laboratory testing of materials, and the designing and sales of various railway gear. He was considered a mechanical expert on draft gear and freight-car construction. Assoc. Mem. ASME, 1909; Mem. ASME, 1913.

Elmer Jacob Koski (1896–1960), staff engineer, Stevenson, Jordan and Harrison, Inc., New York, N. Y., died May 12, 1960. Born, Pigeon Cove, Mass., Sept. 30, 1896. Education, BME, Univ. of Cincinnati, 1922. Upon graduating, Mr. Koski joined Warner and Swasey Co., Cleveland, Ohio, as a special tool designer concerning equipment used on turret lathes. He then became a special apprentice in turret lathe operation, and within a year was moved to the sales department as an estimator of machine types for special jobs. In 1925 he became a sales representative for the company, selling turret lathe equipment through personal company surveys. He was with Warner and Swasey Co. for about 30 years, after which he joined Stevenson, Jordan and Harrison, Inc. There he became a senior mechanical engineer, consulting on methods and quality control in many metal-working plants. Jun. ASME, 1922; Assoc. Mem. ASME, 1926; Mem. ASME, 1935. Surviving are his wife, Margaret, and two children.

Robert Lee Morrow (1888–1960), industrial consultant, professor, and author, died at Norwalk Hospital, Norwalk, Conn., July 6, 1960. Born, Madison, N. J., Sept. 4, 1888. Parents, Prince A. and Lucy S. Morrow. Education, ME, Columbia Univ., 1911. Married Helen Britton, 1933. Mr. Morrow was an expert in time-study work. He authored two textbooks in the field, "Time Study and Motion Economy" and "Motion Economy and Work Measurement." For the past year he was a professor of engineering and a consulting engineer with Bridgeport University, and before that a lecturer for the Department of Industrial and Management Engineering at Columbia University. He also was a former adjunct professor at New York University. He began his career as an apprentice machinist with the New London Ship and Engine Co. in 1911. In 1912 he became a factory inspector and safety engineer for Fidelity and Casualty Co. of New York, and until 1922 also served Lumbermans Mutual Casualty Co. in the same capacity, as well as being a time-study and industrial engineer for Winchester Repeating Arms Co., and Spicer Manufacturing Co. (automobile parts). He also was a factory inspector with the Compensation Inspection Rating Board of New York for four years. He was manager of the planning department at International Silver Co., Meriden, Conn., from 1923 through 1928, supervising time and motion studies in 16 factories. In 1929 he became vice-president and operating manager for Eastern Haynes Corp., and three years later formed his own industrial engineering firm, Robert Lee Morrow and Associates. He installed wage-incentive plans in many plants, including book printers and binders, fiber mills, wool dyers, and manufacturers of cans, rugs, and food and metal products. In 1934 he was New York State safety supervisor for the Civil Works Administration and the Temporary Emergency Relief Administration, supervising safety engineering on many types of construction. Jun. ASME, 1913; Assoc. Mem. ASME, 1922; Mem. ASME, 1929. Surviving are his wife; two daughters, Mrs. William Robertson Bach and Miss Deborah Morrow; a son, Thomas; and one grandchild.

George Christian Pinger (1881–1960), retired engineer, died June 5, 1960. Born, Albuquerque, N. Mex., May 29, 1881. Education, ME, Cornell Univ., 1905. Before completing his education, Mr. Pinger served as an apprentice with five companies in Peoria, Ill., during respective summer vacations. Then he went with Snow Steam Pump Works, Buffalo, N. Y., as a draftsman, and subsequently filled the same position with Struthers Wells Co., Warren, Pa., where he stayed until 1909. Other positions were held by Mr. Pinger with Republic Iron and Steel Co., Youngstown, Ohio; Pittsburgh Crucible Steel Co., Midland, Pa.; West Conduit Co., Youngstown; Youngstown Sheet and Tube Co.; and Lachman Manufacturing Co., New York, N. Y. He was a mechanical engineer and general superintendent with Concrete Steel Co., New York, N. Y., from 1918 to 1942, holding the office of chairman of the Iron and Steel Division, Metropolitan Section, from 1931 to 1935. His work included designing and building several plants. In 1943 he joined the George S. May Co., New York, N. Y., as a mechanical engineer in methods and incentives. He was the author of an article entitled "Open-Truss Steel Joist—Its Genesis and Future," published in *Iron Age*, 1934. Jun. ASME, 1907; Mem. ASME, 1946. He is survived by his wife, Cynthia.

Michael Schwarz (1882–1958), semi-retired as director, Crunden Martin Mfg. Co., St. Louis, Mo., died Sept. 20, 1958. Born, Gross-Jena, Austria, Feb. 4, 1882. Parents, Jacob and Elizabeth Schwarz. Education, attended Technical Industrial School, Austria. Married, 1910. Mr. Schwarz came to the United States from Austria in 1902, where his early career was occupied as a machinist and assistant erecting engineer. Upon arriving in this country, he went directly to St. Louis, where he joined Christopher-Simpson Iron Works Co. as a machinist, and later became a master mechanic. He designed and maintained special dies and all machine tools in the plant. In 1911 he went with Schoenthaler Mfg. Co. as a master mechanic, and shortly thereafter became superintendent in general charge of designing, rebuilding, and installing special machinery in the plant. He later joined Crunden Martin Mfg. Co., where he became vice-president and director. Assoc. Mem. ASME, 1915; Mem. ASME, 1935. Surviving are three sons, Emil A., William E., and Robert E., and one daughter, Elizabeth.

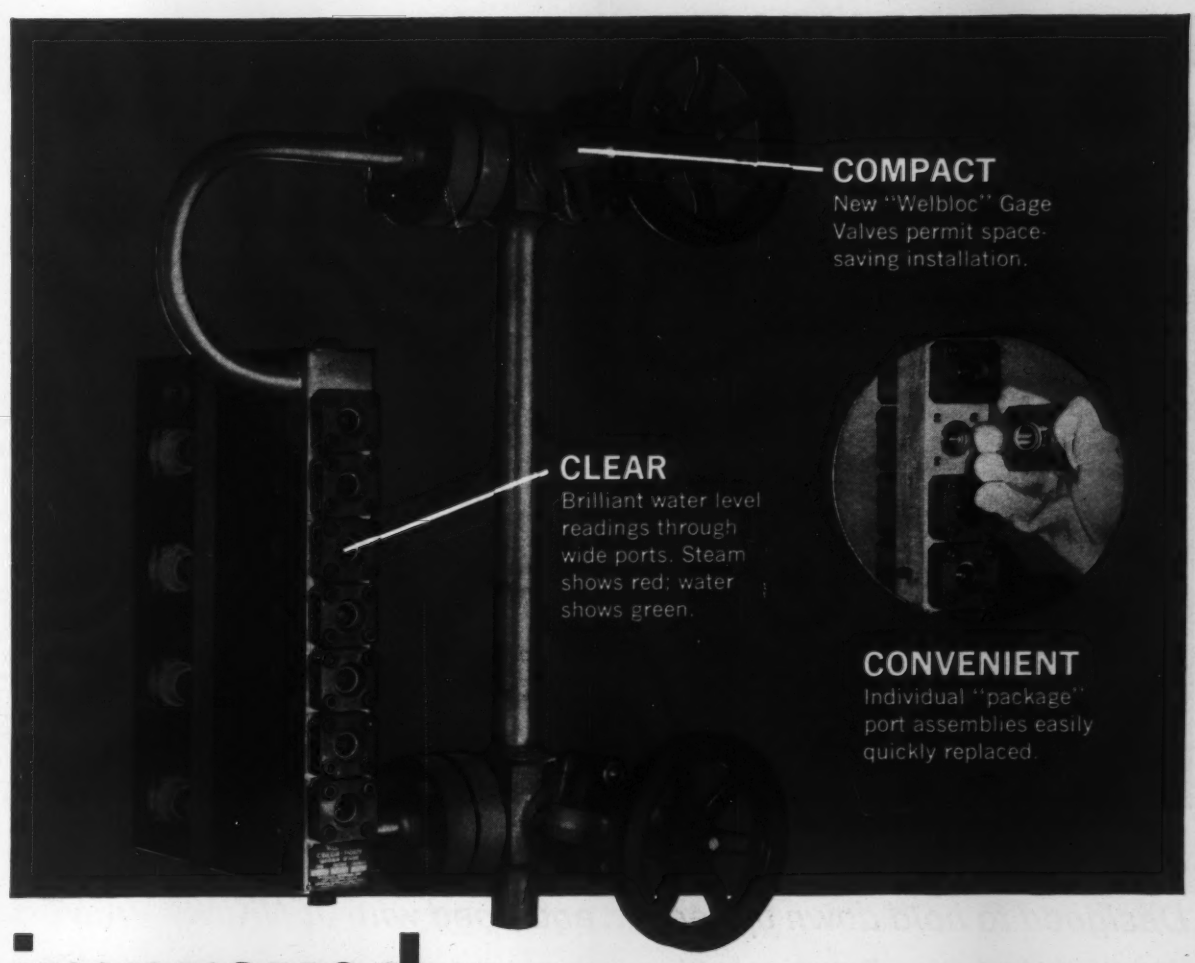
John George Shodron (1883–1960), consulting architect and engineer, died, Milwaukee, Wis., Nov. 18, 1959. Born, Milwaukee, Jan. 24, 1883. Education, ME, Marquette Univ., 1937. Married Winifred McCormick, 1908. Mr. Shodron interrupted his career in research engineering to complete his college education at the age of 54. He had been with James Manufacturing Co., Fort Atkinson, Wis., since 1913, and was vice-president in charge of engineering research and design. His work was concerned with dairy-stable equipment, egg incubators, and steel buildings. He assembled a complete research laboratory at the firm. After his graduation from Marquette in 1937, he operated as a consultant out of his home in Milwaukee, and was a member for 13 years of the school's mechanical-engineering department faculty. The first stages of his career included designing machine tools and other equipment for the Allis-Chalmers Co., Milwaukee; steam shovels and dredges with the Bucyrus Co., also Milwaukee, and reinforced-concrete and steel industrial buildings. In 1908 Mr. Shodron established his own consulting business, which he maintained until joining the James firm. He was granted about 40 patents while with the firm. Assoc. Mem. ASME, 1908; Mem. ASME, 1921. He also was a member of Sigma Tau Delta, and Triangle, engineering fraternities, as well as ASHAE and AWS, and was a registered architect in the State of Wisconsin. Surviving are his wife, Florence; two daughters, Mrs. Edward Brady, York, Pa., and Mrs. Harry Wilkins; and a son, John, of Deerfield, Ill.

David Meade Strauchen (1884–1959), consulting engineer, Cincinnati Milling Machine Co., Cincinnati, Ohio, who also maintained a private consulting service, died Dec. 12, 1959. Born, Clarion, Pa., Sept. 8, 1884. Education, attended Rochester Business Institute and Rochester Mechanics Institute; ME, Univ. of Rochester. Married Amelia Griep, 1906 (dec.) A specialist in machine design, Mr. Strauchen served an apprenticeship at the M. D. Knowlton Co., Rochester, N. Y., manufacturers of paper-box machinery, and was a machine operator at Gleason Works, Rochester, before going with Eastman Kodak Co. in 1910. He spent several years developing die-casting work in the Camera Works Division, and also worked on die sinking. He built the plant's first mold and die-casting machinery. In 1917, he joined Stromberg Carlson Telephone Co., Rochester, continuing in the same capacity as at Eastman. During his early career, Mr. Strauchen also served as a designing engineer on tools and special machinery with North East Electric Co., Rochester; and as a tool engineer with Ritter Dental Mfg. Co., Inc. In the latter position, he controlled tool designing, planning, estimating, and processing in several departments of the plant, which manufactured electrical dental appliances such as x-ray machines, dental engines, and laboratory motors. Mr. Strauchen also taught machine-design courses at Rochester Mechanics Institute, and mathematics in Rochester evening schools. Mem. ASME, 1925. Member also, ASM, and Engineering Society of Cincinnati. Surviving are two sons, Edmund Rudolph Meade, Indian Hill Village, Ohio, and Gilbert William MD, St. Louis, Mo.

Robert Gay Trumbull (1890–1960), assistant professor of engineering drawing, Univ. of Tennessee, died May 28, 1960. Born, Worcester, Mass., Sept. 4, 1890. Education, BS, Worcester Polytechnic Institute, 1913. Mr. Trumbull was an instructor in engineering drawing at Pennsylvania State College for three years after his graduation. In 1916 he went with the Wiley-Bickford-Sweet Co., Worcester, as a cost man in charge of estimating costs of military clothing and related equipment. Then he became, successively, a draftsman with Boston and Albany Railroad, Boston, 1918–1919; chief estimator of railroad-passenger cars with Osgood Bradley Car Co., Worcester, 1919–1927; fixture draftsman working on internal-grinding machinery with Heald Machine Co., Worcester; and designer with New England Electric System, Boston, where he was in charge of the structural design of three major indoor bus structures. He was with the American Steel and Wire Co., Worcester, as a draftsman on aerial tramways in 1934; and in 1936 was principal and chief draftsman on flood control work with United States Engineer Offices, Providence, R. I., and Los Angeles, Calif. He resumed work with railway equipment as an associate engineer with United States Engineer Board, Fort Belvoir, Va., in 1941, developing railway motive power and rolling stock for army use. In 1942 he returned to the teaching profession as an associate professor of mechanical engineering at George Washington University, Washington D. C. He continued teaching from then on, later going to the University of Tennessee. Mem. ASME, 1950.

William B. Tucker (1894–1960), sales representative, Allis-Chalmers Mfg. Co., Milwaukee, Wis., died June 18, 1960. Born, Centreville, Md., Dec. 23, 1894. Parents, William C. and Mary F. Tucker. Education, BS, St. John's College, Annapolis, Md., 1917; BE, The Johns Hopkins Univ., 1923. Mr. Tucker joined Allis-Chalmers upon graduating in 1923, and remained with the company until his death. He specialized in the sales, design, and testing of steam turbines. Before 1923 he worked as a tool grinder for Ithaca Gun Co., Ithaca, N. Y., and for Buick Motor Co., Flint, Mich. He also was briefly associated with Western Electric Co., Baltimore, Md. Jun. ASME, 1923; Assoc. Mem. ASME, 1930; Mem. ASME, 1935. He was a registered professional engineer in the State of Wisconsin.

Charles C. Willis (1884–1960), retired mechanical engineer, died June 22, 1960. Born, Hoosick Falls, N. Y., Feb. 17, 1884. Parents, George and Harriet (Gibson) Willis. Education, SB, Harvard Univ., 1907. Married Gladys Wheeler, 1911. Mr. Willis specialized in machine design, particularly in the paper-products and handling field. After a two-year period as a foreman with Sullivan Machinery Co., Claremont, N. H., the company he joined after being graduated, he went with Dennison Mfg. Co., Framingham, Mass., where he held various positions in drafting, machine, and process development. When he resigned from the company in 1927, he had charge of drafting and experimental work, and process development. Then he became treasurer and general manager of the John Waldron Co., New Brunswick, N. J., moving up to president in 1929. His work there was in the coupling and paper-converting fields. In 1938, after a period of travel, he became vice-president of Swift Business Machine Corp., New York, N. Y., in the development and production of a small adding machine. Following a leave of absence from the company pending retooling operations in 1940, he went with the Bureau of Industrial Relations Inc., New York, N. Y., as vice-president in charge of production. Later, he became self-employed. He held several patents on paper-converting machinery. Mem. ASME, 1920. Member also, Technical Association of the Pulp and Paper Industry. Surviving are his wife; three sons, Roger W., Ogden Dunes, Ind., George G., Framingham Center, Mass., and John R., Ann Arbor, Mich.; and two daughters, Barbara W. Heinrich, Baytown, Texas, and Harriet W. Williams, Golita, Calif.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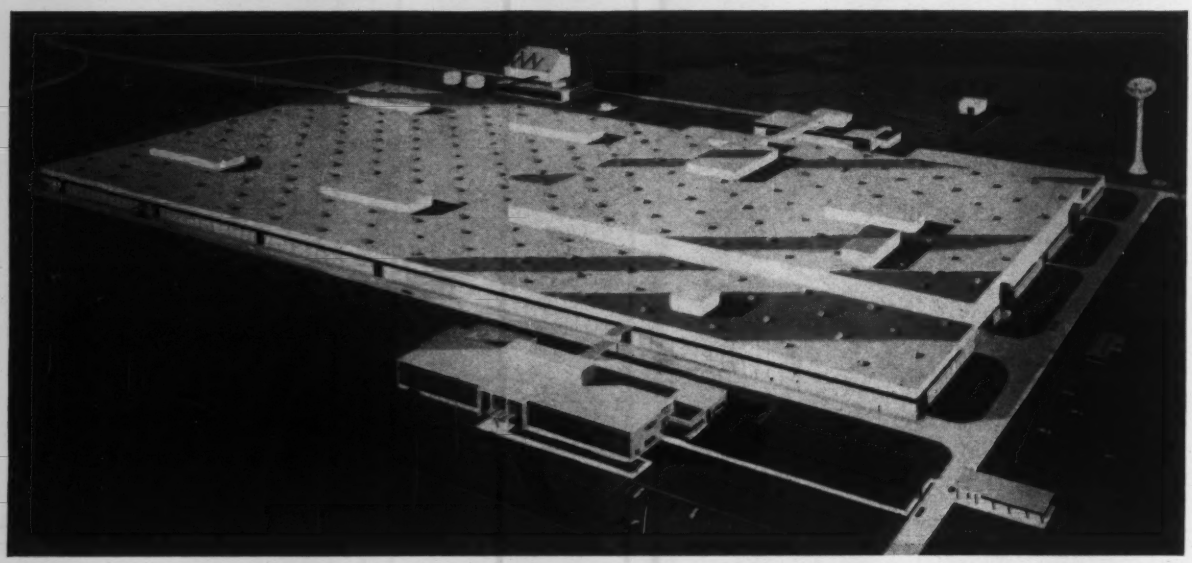
General Chemical Co.
University of Texas
Pittsburgh Plate Glass Co.
Youngstown Sheet & Tube Company
E. I. du Pont de Nemours & Co.
Scott Paper Company

NEW CHRYSLER CAR-A-MINUTE ASSEMBLY PLANT



ADMINISTRATION BLDG. — *Architects and Engineers:* SVERDRUP & PARCEL, St. Louis • *General Contractor:* FRUIN-COLNON CONTRACTING CO., St. Louis
ASSEMBLY BLDG. — ALBERT KAHN, *Associated Architects and Engineers,* Detroit • H. D. TOUSLEY CO., *General Contractor,* Kirkwood, Mo.

Designed to hold down upkeep... equipped with JENKINS VALVES

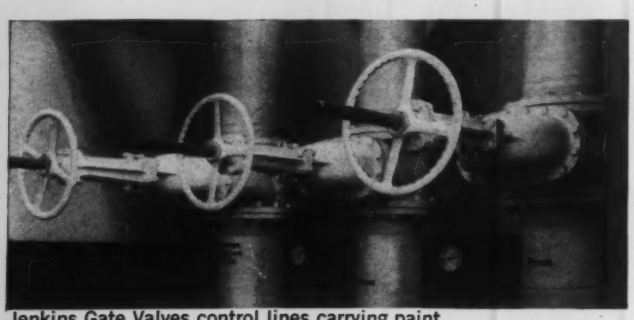
Chrysler Corporation's St. Louis assembly plant serves the midwest, employs more than 4000 in building Valiant, Plymouth, Dodge Dart and new Dodge Lancer cars. Seven buildings include a 1.3 million square-foot manufacturing building and a U-shaped administration building of reinforced concrete columns and girders, with pre-cast concrete floor and roof deck.

Designed to be "the nation's most modern automobile manufacturing facility," this huge new plant also represents an all-out effort to make it a record-breaker in terms of low upkeep.

That Jenkins Valves would minimize valve maintenance and replacement costs was assured by the service records of Jenkins Valves in other Chrysler Corporation plants.

By installing Jenkins Valves to control customary service lines and the extensive paint carrying system in the St. Louis plant, Chrysler guaranteed dependability and economy. Yet, the Jenkins Valves cost no more.

You can take the gamble out of valve costs with one word in your specifications or purchase order . . . the word for economy: "JENKINS." For information about specific valves, ask your local Jenkins Distributor or write—Jenkins Bros., 100 Park Ave., New York 17.



Jenkins Gate Valves control lines carrying paint as well as plumbing, heating, air conditioning.

JENKINS
LOOK FOR THE JENKINS DIAMOND
VALVES
JENKINS
SINCE 1864
Jenkins Bros

Sold Through Leading Distributors Everywhere

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NEW EQUIPMENT

Hydraulic Press

A high-speed, hydraulic press for the stamping industry has been announced by Denison Engineering Div., American Brake Shoe Co. The new 25-ton hydraulic press, is capable of delivering over 600 ram strokes per min.

Designed for high-speed progressive stamping operations, it is a vertical-frame, four-column design platen press, equipped with a No. 3-6-1/2 Littell roll feed, stock oiler, and variable-speed straightener. Bed area between guide posts is 20 x 20 in. There are a variety of optional bed bolster plates available. Daylight area is 13 in. which can be mechanically adjusted with a screw thread a total of 3 in.

The press contains a closed-circuit hydraulic system, servo drive, with harmonic cam drives for work strokes of 1/4, 1/2, 3/4, 1, 1 1/2, 2, and 3 in. Cams can be varied to permit special work strokes.

An important feature is that the number of ram strokes can be changed while the machine is cycling. Pressures can also be changed while the machine is in operation. Through the servo-loop system, feed control is automatically sequenced to any changes in ram stroke.

The 25-ton unit will produce electric-motor laminations, two per ram stroke, from 0.025 by 3-in.-wide silicon-steel stock.—K-1

Torque Converters

An expansion of its line of single-stage torque converters enables Twin Disc Clutch Co. to meet any application requirement in the 100 to 300-hp range. They are industrial units, not adaptations of converters designed for automotive use. Impeller, impeller cover, and turbine are precision aluminum castings. The reactor member is a fabricated assembly of steel air-foil-section blades with heavy stamped-steel shells. Stationary housings are of conventional gray iron.

Three series of single-stage converters are offered—1100, 1300, and 1500 series. The first two digits in the series number indicate approximate circuit size in inches. Each series has five interchangeable impellers. Changing the impeller has the effect of changing torque-absorption capacity, since the impeller blades vary with respect to number and pitch.

This exclusive Twin Disc design feature provides a 2 : 1 horsepower spread for each series of converter. It insures correct matching of converter to engine and also permits engine horsepower delivery to be increased at a later date without dimensional changes in the torque-converter package.

There are no horsepower or speed gaps between series in the Twin Disc line. The 1500 series is furnished in two capacity designs. The standard unit is limited to 450 lb-ft input torque; the heavy-duty 1500 series, though its circuit is identical, is reinforced at high stress points and equipped with larger bearings to handle 650 lb-ft. —K-2

Turbine Fuel Control

A turbine fuel control weighing only 1.875 lb, complete with shutoff solenoid, has been added to the extensive family of similar controls built by the Garrett Corporation's AiResearch Mfg. Div.

Capacity of the unit's gear-type pump is 200 lb per hr of JP-4 at 200 psig and 4250 rpm. The control will also handle gasoline or diesel fuel.

Fuel-flow scheduling and limiting is pneumatically regulated from the compressor during acceleration. For a metered flow variation of 10 to 60 lb per hr a 4 per cent speed drop is typical.

Flowing JP-4 at 100 F, allowable control input pressure range is −3 to +15 psig.

The governor may be externally adjusted ±20 per cent from standard rpm. A 10-micron filter is also incorporated in the unit.

Current applications for the tiny control include use on AiResearch small gas turbines in the 30 to 50-hp range. —K-3

Lining Material

Penton sheet stock specifically for vessel-lining application is being marketed by U. S. Gasket Co., Plastics Div. of Garlock Inc. Penton is a chlorinated polyether compound exhibiting excellent environmental characteristics for most process-industry applications.

A true thermoplastic material it is currently being supplied in extruded sheet form 0.040 in. thick by 21 in. wide. U. S. Gasket also supplies welding-seam strip and welding rod. Penton is welded in a manner similar to PVC, and is seamed with a heat gun.

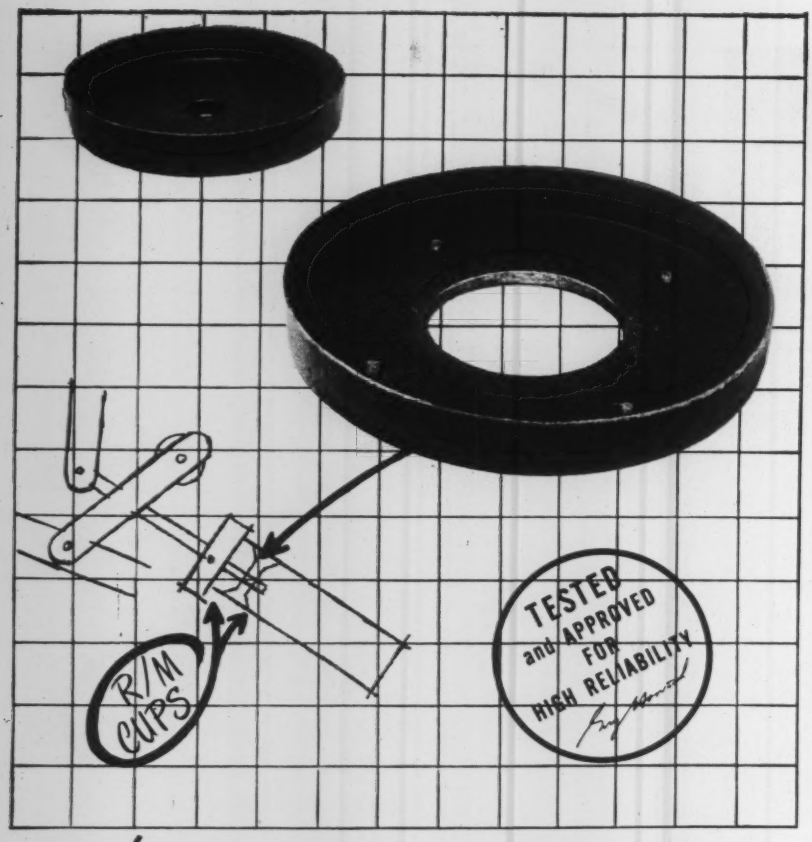
Penton has excellent resistance to corrosives, bleaching agents, solvents, and plating solutions and is serviceable up to 280 F. The material can be used to line vessels of unlimited size and is not subject to thermal shock. It has excellent abrasion and impact resistance qualities and is simple to apply to virtually any contoured surface. —K-4

Welded Steel Tubing

Size ranges of square, rectangular, and round welded-steel tubing made by Standard Tube Co. have been increased.

Welded steel tubing is now available in 4-in-OD square cross-sections with standard-radius corners in all wall thicknesses up to and including 0.270-in. In addition, wall-thickness ranges on 5-in-OD round and 3 × 5-in-OD rectangular are increased to 0.270-in.

Tooling has also been installed for 3 × 6-in-OD rectangular and 5 3/4-in. round with wall thicknesses also up to 0.270-in. New rolling-mill accessories will now place Standard Tube in a position to offer standard radius corners in all gages indicated for a wider range of applications. —K-5



R/M CAPABILITY

develops new piston cups of Teflon®-impregnated asbestos fabric

... for all hydraulic fluids
... for temperatures to 500°F

Check these important advantages of new R/M Piston Cups — first molded hydraulic and pneumatic packings to outperform all elastomer-type piston cups:

- Minimum thermal expansion and plastic flow
- Superior extrusion resistance
- Broad chemical resistance
- Low coefficient of friction without aid of lubrication
- Permit operation at temperatures to 500°F—under certain conditions to 650°F (elastomer-type piston cups are limited to 300°F)
- High or low pressures are handled with one type of material
- Serviceable at temperatures below −100°F

Get more information about these new R/M Piston Cups. Write for a copy of Bulletin P-8907.

*Du Pont trademark for its TFE-fluorocarbon resin

R/M PACKINGS
RAYBESTOS-MANHATTAN, INC.
PACKING DIVISION, PASSAIC, N. J.
MECHANICAL PACKINGS AND GASKET MATERIALS

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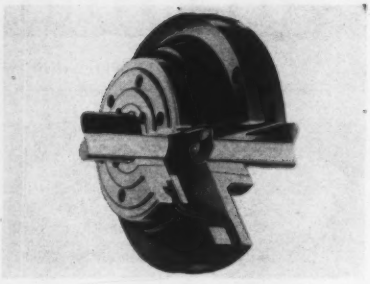

Flexible Cushion Couplings

A pan-shaped rubber flexing element of entirely new design is the feature of two new cushion-type couplings being introduced for high-speed or high-torque applications by Dodge Mfg. Corp.

These new couplings are identified by Dodge as Para-flex High Speed and Para-flex Flywheel types. Like the original standard tire-type cushioned couplings introduced in 1957, both new types are recommended to accommodate, either singly or in any combination, angular and parallel shaft misalignment and end float, to absorb torsional vibration, and to cushion shock loads.

The High Speed coupling consists of the flexible member supported on one side by a clamp-ring flange just like those furnished with the tire-type coupling, and with its larger side bolted to a steel disk. Both the flange and disk are equipped with Taper-Lock bushings for quick and easy mounting on shafts.

Designed for speeds up to 5230 rpm, the High Speed coupling may be used with electric motors or internal-combustion engines to operate such equipment as hammer mills, compressors, pumps, high-speed fans, marine drives, and blowers. They are equally efficient on low-speed applications where torque requirements are high.

The Flywheel-type coupling is like the High Speed Para-flex except that its larger side bolts directly to the flywheel of an internal-combustion engine instead of being supported by a taper-bushed steel disk. These couplings are offered in sizes to fit the bolt circles of most standard SAE flywheels up to 19¼ in. dia.

Flexing members of both new types absorb noise-producing vibrations, and serve to prevent the flow of electrical current between shafts—there is no metal to metal contact. Para-flex couplings require no lubrication.

High Speed and Flywheel couplings are now offered in sizes to deliver up to 47 hp per 100 rpm and with Taper-Lock bushings to fit shafts up to 4 in. in dia. Hubs can be ordered bored to size to fit larger shafts.

—K-6

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Cutters and Flangers

A modernized line of power-operated ring, circle, slitting shears, and flangers by Niagara Machine & Tool Works, improves speed and accuracy in circular cutting and flanging operations.

Designed for medium and heavy sheet-metal work, the line consists of six basic types of machines: (*a*) Three models of ring and circle shears with capacities from 10-gage to $^{3}/_{8}$-in. mild steel for cutting circles 6 to 72 in. in diam, starting on the inside or from the edge of square blanks; (*b*) six models of circle shears with capacities of $^{1}/_{8}$ through $^{1}/_{4}$-in. mild steel for cutting circles 10 to 58 in. in diam, starting at the edge of square blanks; (*c*) six models of slitting shears with capacities of $^{1}/_{8}$ through $^{1}/_{4}$-in. mild steel for slitting sheets of any length into widths $^{5}/_{8}$ to 23 in. wide; (*d*) combination ring and circle shears and flanger which cuts disks 8 to 58 in diam starting at the edge of square blanks (8-gage mild steel and 12-gage stainless), turns flanges up to $1^{1}/_{2}$ in. high, forms truly round heads from $18^{1}/_{2}$ to $73^{1}/_{2}$ in. diam, with special cutter, disks $19^{1}/_{2}$ to 58 in. in diam can be cut, starting from the inside or at the edge of square blanks; converts to ring and circle cutter, to circle cutter, to flanger in minutes. (*e*) combination circle shear and flanger, for light work it cuts disks 5 to 48 in. in diam from square blanks of 18-gage mild steel. Turns flanges up to 1 in. high, forms heads 10 to 48 in. in diam inside flanges; for heavy work it cuts 17 to 80 in. diam disks from square blanks of $^{1}/_{4}$-in. mild steel, turns flanges up to $2^{1}/_{4}$ in. high, through use of pin pivot, larger diameters (up to 120 in.) can be cut from square blanks; (*f*) flanger for extra heavy work which produces flanged heads 26 to 105 in. in diam (inside flanges) from $^{3}/_{8}$-in. mild steel plate, heads up to 226 in. diam can be produced through use of pin pivot, maximum flange height is 3 in.

Cutters on all shears are precision ground, special grade, heat-treated alloy tool steel. Flanging rolls are case-hardened, high-grade steel. Standard rolls form a $^{1}/_{2}$ in. radius at the root of the flange. Rolls for other radius can be furnished to special order.

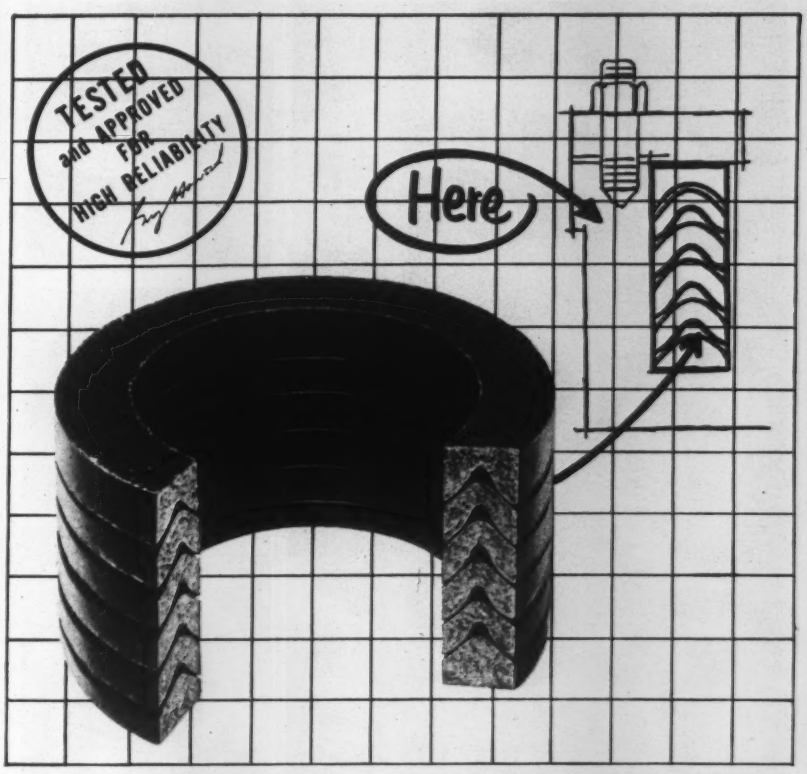
Accessories such as pin pivots, air-operated clamping devices, and special circle arms further increase the range and utility of this Niagara line. Request Bullletin 70 G.

—K–7

Universal Joints

The most frequently used sizes of universal joints are available in stainless steel from stock at Boston Gear Distributors. The selection includes solid or bored types in 10 sizes, $^{5}/_{8}$ to 2 in. diam, and $1^{3}/_{4}$ to $5^{7}/_{16}$-in. over-all lengths.

Complete information is listed in the New Products Supplement to Catalog No. 57, available from Boston Gear Works. —K–8



R/M CAPABILITY

develops new Vee-Flex® Packing Rings of Teflon®-impregnated asbestos fabric

... for all hydraulic fluids
... for temperatures to 500°F

Check these important advantages of new R/M Vee-Flex® Rings — the first molded hydraulic and pneumatic packings to outperform all elastomer-type V-rings.

- Minimum thermal expansion and plastic flow
- Superior extrusion resistance
- Broad chemical resistance
- First V-rings capable of constant low coefficient of friction without aid of lubrication
- Permit operation at temperatures to 500°F—under certain conditions to 650°F (elastomer-type V-rings are limited to 300°F)
- High or low pressures handled with one type of material
- Serviceable at temperatures below –100°F

Get more information about these new R/M Vee-Flex Packing Rings. Write for a copy of Bulletin P-8907.

*Du Pont trademark for its TFE-fluorocarbon resin

R/M PACKINGS
RAYBESTOS-MANHATTAN, INC.
PACKING DIVISION, PASSAIC, N. J.
MECHANICAL PACKINGS AND GASKET MATERIALS

You get greater strength . . . with

SHENANGO CENTRIFUGAL CASTINGS

Downtime, rejects, heavy maintenance costs and too-frequent replacements can be cut down *appreciably* by the use of Shenango extra-strong centrifugal castings.

They provide a finer, *pressure-dense* grain . . . with all the weakening defects eliminated, such as blowholes and sand inclusions.

Though built to stand the most rugged service, each Shenango casting is precisely-dimensioned to your exacting requirements. Whether you need rolls, bearings, bushings, mandrels, sleeves, liners, or any other essentially symmetrical part . . . *specify Shenango* for greater strength, greater wear-resistance, greater lasting power and greater savings, year after year.

Informative bulletins are yours for the asking. Write to: *Centrifugally Cast Products Division,* The Shenango Furnace Company, Dover, Ohio.

SHENANGO CENTRIFUGAL CASTINGS

COPPER, TIN, LEAD, ZINC BRONZES • ALUMINUM AND MANGANESE BRONZES
MONEL METAL • NI-RESIST • MEEHANITE METAL • ALLOY IRONS

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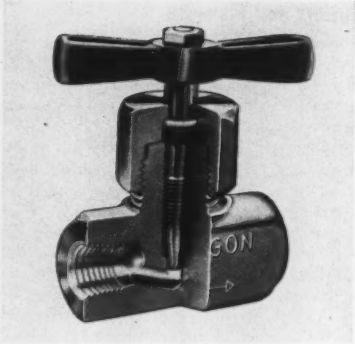

Needle Valve

A Series 5000 general-purpose Needle Valve, low-cost operation-rated for 10,000 psi, has been developed by Dragon Engineering Co. Safety is stressed through design innovations which prevent the valve stem from blowing out or backing out under pressure. Absolute stem retainment has been achieved by making inside neck threads an integral part of the one-piece forged carbon-steel valve body, which has been precision machined to ensure absolute alignment of stem to seat.

The stem is made of corrosion-resistant stainless steel. Stem threads are rolled for added strength and turning ease. The stem protrudes through a wrench-tightened nut which won't come loose, further safeguarding against stem "blowouts" or "backouts."

A Teflon backup ring prevents dirt or contamination from entering valve. O-ring stem sealing prevents leakage.

The valve is designed with a minimum four-to-one safety factor which meets or exceeds all published specification requirements and makes it adaptable to high-pressure applications in oil-field equipment, refineries, and on test and instrument panels. **—K–9**

Tape Dispenser

A new, wafer-thin plastic container for fast dispensing, protecting, and storing of precision-slit pressure-sensitive tapes has been introduced by Chart-Pak, Inc.

Called a Tape-Saver dispenser, it is used for packaging the company's entire line of narrow industrial, statistical, and charting tapes—including Scotch-brand tapes used specifically for engineering drawings, charts, and graphs, printed circuitry, plant and office layouts, and transparent projections.

Only $1\frac{3}{4}$ in. in diam these handy, pocket-sized dispensers are designed for tapes ranging in width from $\frac{1}{64}$ to 2 in. They provide easy dispensing by enabling the tape ends to be quickly grasped for fast application. **—K–10**

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Time Totalizer

Type 620, made by Cramer Controls Corp., is a compact, lightweight, and rugged elapsed-time indicator designed for reliable performance under severe operating conditions covered by MIL-M-7793B and MIL-E-5272B.

It will accurately register up to 9999.9 hr total operating or nonoperating time for any type of electrically controlled equipment. Small size and light weight make it suitable for airborne applications.

The entire unit weighs about 4 oz, is hermetically sealed, and dimensionally meets MS-28053 and NEMA standards. Required operating power is 115 volts at 60 cps (permanent-magnet synchronous type) or 400 cps (hysteresis-synchronous type). Housing forms are available for front or back-panel mounting.

The precision drum-type counter is driven by a constant-speed motor from the instant power is applied to the motor circuit, and has a minimum life of 10,000 hr. —K-11

Rotary Pumps

Built-in relief valves are available as an optional feature on Warren Pumps, Inc., TS line of screw pumps and most sizes of Rotex gear pumps. The newly designed valves are single-seat type, top-guided design, and have renewable ductile-iron seats. Required relieving pressure is factory set.

Write for Bulletin No. 253. —K-12

Power Steering

Completely integrated power-steering systems, claimed to be the first to be designed and produced by a single manufacturer since the advent of power steering, have been disclosed by Vickers Inc.

They may be applied effectively and at lower cost to all highway and off-the-road motor vehicles and eliminate the expense of custom-built components. They are designed for vehicles with axle loadings of 1500 to 128,000 lb. The upper limit is greatly in excess of any maximum axle loadings envisioned. —K-13

MANY FAST'S HAVE BEEN WORKING LONGER THAN YOU

It's a fact. There are plenty of cases where Fast's Couplings have been in service 20 to 40 years. And some of our more enthusiastic engineers say a Fast's should last forever if it's properly applied, installed and lubricated. Whatever opinion you accept, you can bet Fast's Couplings will give you the same smooth-running, low-maintenance, long-lived performance that makes them the choice of more equipment manufacturers than any other gear-type coupling.

For example, Fast's Coupling No. 1347, shipped in July, 1922, is still in service—and the customer is just ordering his first spare coupling 38 years later.

KOPPERS COMPANY, INC., 510 Scott Street, Baltimore 3, Md.

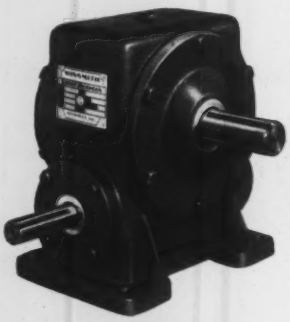
KOPPERS FAST'S COUPLINGS
Engineered Products Sold with Service

DISCERNING DRAFTSMEN THE WORLD OVER DEMAND IMPERIAL THE WORLD'S FINEST TRACING CLOTH

Lindberg Roller Hearth Solution Treating Furnace, showing some of the 101 Winsmith Model 2CB Reducers which drive the rolls. An additional Model 7CT is also installed. The heating chamber of this furnace is 100 feet long with 40 feet of quench chamber.

LINDBERG ENGINEERING USES 102 WINSMITH SPEED REDUCERS

on their Roller Hearth Furnaces



LINDBERG ENGINEERING COMPANY of Chicago is a leading manufacturer of heat treating furnaces. When they designed this one to handle 4,000 lbs. of aluminum extrusions per hour, specifications called for 101 speed reducers to drive the rollers. They selected Winsmith for compact size, rating and their record of past performance. Lindberg is a long-time Winsmith customer. They describe the relationship this way..."We have used Winsmith Reducers for many years and have found their reliability and ruggedness ideal for use with our heat treating furnaces."

Lindberg Engineering is another one of the leading American manufacturers who specify Winsmith Speed Reducers for most applications from 1/100 to 85 hp.—in ratios from 1.1:1 through 50,000:1.

WINSMITH SPEED REDUCERS

WRITE TODAY for complete selection information and engineering data. You'll see for yourself why it pays to standardize on Winsmith.

MEMBER OF AGMA

WINSMITH, INC.

20 Eaton Street, Springville, (Erie County), N. Y.

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Miniature Ball Bearings

Miniature Precision Bearings, Inc., has developed a new double-sealed "blister" pack to prevent contamination and to prolong the shelf life of its products.

The result of two years extensive research, the new package consists of individual clear-plastic cavities, each containing a predetermined excess of preservative oil which covers the bearings. The "blister" plate and covering sheet are made of 15-mil butyrate. They are sealed electronically, both around each "blister" cavity and along the edge of the $1\frac{3}{8}$-in. individual package. Shelf life is more than five years.

The "blister" packs come in sets of ten. Each pack is imprinted with the bearing number, the Federal stock number and the date of packaging to simplify inventory control.

The packages for the company's nonmilitary customers have also been redesigned. Strips of clear heat-sealable polyester film 2-in. wide are now being used. After a bearing is inserted in its individual pocket, the polyester material between each of these containers is perforated and cut into strips containing 5 bearings each. A standard shipping container will consist of 10 of these strips containing 50 bearings to a box.

This new strip pack will withstand temperature variations from + 230 to − 80 F and the lubricant used in the bearings will not discolor it while the bearings are in storage. There is no possibility of air leaking in. —K-14

Power Relays

New Type CW power relays to detect excessive or reverse power flow for single or three-phase applications are offered by the Westinghouse Electric Corp. Both relays are self-contained (requiring no external reactors) and are available for 120 or 208-volt systems.

The relay for single-phase application uses line voltage and line current. It operates on single-phase watts, with maximum torque occurring when the voltage and current are in phase.

The relay for three-phase application uses phase-to-phase voltage and line current, with maximum torque occurring when the relay current leads the relay voltage by 30 deg at system unity power factor. It operates on single-phase watts multiplied by 3. One relay is required for balanced three-phase systems, and three are needed when unbalanced three-phase conditions exist.

Some design features include a tap block which indicates watt values; an adjustable time delay; silver moving contacts that close 30 amp at 250 volts d-c; silver stationary contacts with sufficient wipe to assure positive contact; and a one-piece die-cast aluminum frame which assures accurate alignment of moving parts and stationary components. —K-15

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Constant-Torque Spring Motor

An interesting new variation of the constant-torque spring motor has been developed by the Hunter Spring Co., Div. of American Machine & Metals, Inc. The new motor differs from other Hunter Neg'ator constant-torque spring motors in that it utilizes an extremely wide band of spring material giving it a long, tubular shape. This shape opens up many new applications for the constant-torque spring motor; for example, internal mounting in drums, instrument-chart drives, long slender members, tubes, masts, and similar items.

The spring material is a flat strip of stainless steel, 0.0033 in. thick and $7^7/_8$ in. wide, which has been given a curvature by continuous heavy forming so that in its relaxed condition it is a tightly wound roll of flat material. Cross-curving effects have been eliminated in mounting the spring material on two steel drums. The drums are bearing-mounted in the frame for low-friction so that a constant force is exerted as extension of the output cable winds the Neg'ator from its relaxed condition on the smaller $^1/_2$-in-diam drum onto the larger $^3/_4$-in-diam output drum. Constant torque of 6 lb-in. is developed through 50 revolutions of the output pulley at all positions of cable extensions.

As with other constant-torque Neg'ator B-motors, the new scroll-type will be designed for individual applications. The shape of the motor will adapt to either flat or tubular spaces; and, of course, other drives such as gears are available. —K–16

Overhead-Crane Components

The Hoist & Crane Div. of Robbins & Myers, Inc., has introduced a new line of crane end trucks and accessories designed for users who wish to assemble their own overhead traveling cranes. All necessary components except the structural-steel bridge girder and the drive shaft are supplied.

There are 18 ratings for spans to 50 ft. Load capacities range from 1 to 10 tons.

Both light-duty and heavy-duty models are available. Light-duty models are motor-driven and are offered in either top-running or underhung construction. They are powered by a head-mounted motor on each end truck. The heavy-duty models are motor-driven top-running and hand-geared top-running.

A line of torque-arm center-drive assemblies is available for heavy-duty motor-driven designs. These drives are shaft-mounted, thus eliminating the need for heavy structural-support members.

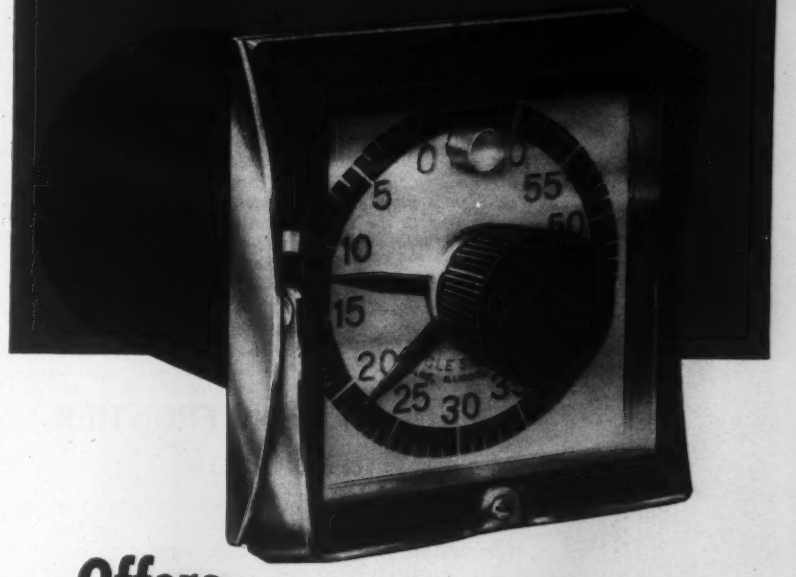
Other available accessories include magnetic controls, current collectors, and cross-shaft bearings and couplings.

Complete assembly instructions are furnished with each set of crane components. —K–17

new *plug-in timer*

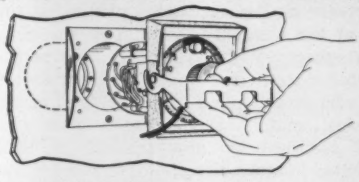
for controlling industrial processes

EAGLE'S HP5 CYCL-FLEX

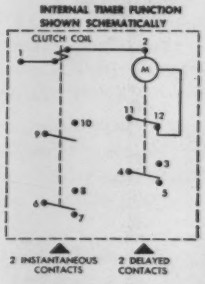


Offers:

- *Fast, easy installation*
- *Quick change of time ranges*
- *Quick means of localizing trouble*



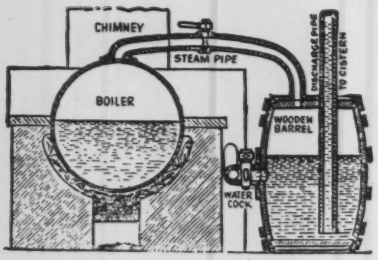
To Remove: Lift handle and pull out



With 4 switches — 2 switches operate instantly when timer is energized — 2 switches operate with time delay — delay time adjustable — selection of dials from 10 seconds to 60 hours. Write Dept. ME-1060.

EAGLE SIGNAL COMPANY
Moline, Illinois

The Most Complete Line of Time-Count Controls



AN ENGINEERING FRONTIER IN 1663...

. . . was finding ways to utilize steam power. In that year, for example, the Marquis of Worcester is credited with inventing the ingenious "steam water lift" shown here. Steam from the boiler passed through a pipe into a wooden barrel. Steam was condensed in the barrel, creating a partial vacuum, which caused water below to rise into the barrel when the water cock was open. When the cock was closed and the steam valve opened, the steam forced the water up through a discharge pipe into a cistern above. It was through trial and error designs like this that the art of steam power generation was first introduced.

AN ENGINEERING FRONTIER IN 1960...

. . . is the development of commercial nuclear power utilizing such modern reactors as the Combustion Engineering design illustrated. Nuclear reactor systems capable of generating economical steam power for commercial use have long been an engineering goal in the American power industry.

Combustion Engineering, recognized internationally as a pioneer in the fast-moving technology of steam power generation, has developed in its Nuclear Division the engineering capability necessary to the successful pursuit of this goal. All of the elements essential to the design and development of well-balanced, high-performance reactor systems are under constant investigation by individuals skilled in the fields of engineering, physics, metallurgy, ceramics and chemistry. Staff positions are now available to individuals qualified in these disciplines.

During 1959, more than 30 large C-E steam generating units with a total capacity of over 5 million kilowatts were installed in utility power stations in this country and abroad. The generation of commercial nuclear power is a natural extension of our product line.

Address inquiries to:
Mr. R. M. Killelea, Manager,
Professional Recruiting, Nuclear Division,
Combustion Engineering, Inc.,
Windsor, Connecticut

NUCLEAR DIVISION

C-E COMBUSTION ENGINEERING, INC.

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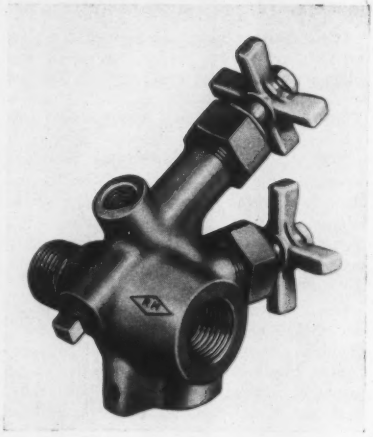
BUSINESS NOTES
NEW EQUIPMENT
LATEST CATALOGS



Draft-Gage Manifold

A draft gage manifold valve for pressure boiler applications has been added to the fluid-system specialty line of the Republic Mfg. Co., makers of valves and other hydraulic components.

Cleaning fly ash and combustion residue from draft-gage lines, usually an unpleasant job, is made easy by the Republic draft gage manifold valve. Disconnecting of lines is not necessary. The unit, singly or in multiple, is permanently connected to the compressed-air supply. The gage line is shut off during blowing off of the draft line, without affecting the gage. A removable plug permits zero check, and the calibration of instruments. Any number of units may be manifolded, with a separate unit for each pointer. **—K–18**

Check Valve

Universal Valve Co. originators of the converted $1^1/_2$-in. extractable angle check valve which permits 2-in. flow in outlet lines without the bulk and higher cost of a 2-in. valve announce Model No. 410T, which can be connected to three tanks simultaneously. The valves are used in the suction line of gasoline and fuel-oil storage tanks to prevent drainage when pumps are inactive and also to maintain fuel in the lines for instant dispensing. The No. 410T is screwed directly into one of the $3^1/_2$-in. tank openings. Accessibility is obtainable through an extended pipe.

To obtain a 2-in. flow without the added bulk encountered in the larger and more costly 2-in. valve, the $1^1/_2$-in. Model No. 410T is provided with 2-in. inlet and outlet openings. In addition to the economy and smaller size of the valve, further savings in man hours are realized by eliminating the necessity of attaching reducers as is required when a standard $1^1/_2$-in. valve is made to accommodate a 2-in. line. **—K–19**

KEEP INFORMED

BUSINESS NOTES
NEW EQUIPMENT
LATEST CATALOGS

Liquid Blending Pumps

A new kind of pump recently introduced by the Blackmer Pump Co. is being used to build simplified, low-cost systems for proportioning liquids. According to the manufacturer, these new systems are being successfully applied to mix two or more liquids in accurate ratios, eliminating much of the costly and complicated equipment that has long been associated with continuous or so-called "line blending."

Secret of the system is Blackmer's new Vari-Flo pump. Essentially, the Vari-Flo s a vane-type positive-displacement pump similar to Blackmer's standard design but with the addition of a unique flow-changing device that varies the pump capacity from zero to full flow. The flow rate is changed instantly and accurately by means of a calibrated dial which can be operated manually or automatically either at the pump or from a remote station. Turning the dial changes the displacement of the pump (by changing the shape of the pumping chamber); thus the flow rate is subject to infinite variations while the pump operates at constant speed.

To put this unique principle to use in proportioning, two or more of the Vari-Flo units (depending on the number of base stocks to be blended) are coupled directly together so that all must turn at the same speed. If the dial settings on each are different, then the flow from each will be proportionately different, even though the units are turning at identical speeds. If one of the units hesitates or stops, all will do the same, and the proper ratio will remain unchanged.

Applications are those involving total flow rates of about 10 to 2000 gpm and more.

The Vari-Flo pumps are available in 2, 3, and 4-in. sizes in four different types. Two types are external-ball-bearing models with mechanical seals. One is for handling solvents. The other types have packing glands for liquids of higher temperature and viscosity. One of these has steam-jacketed heads for heating extremely thick liquids.

—K–20

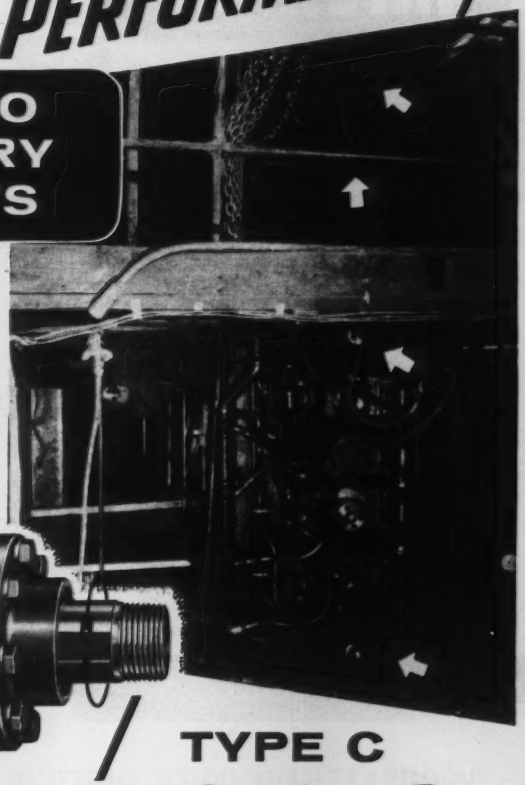
Variable Transformers

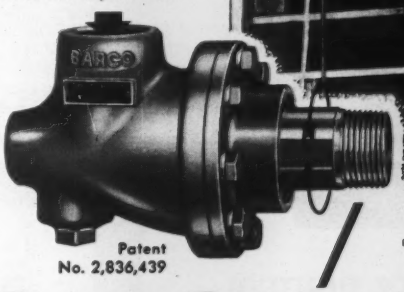
More efficient and flexible design of systems having loads up to 7.5 kva is now possible with the introduction of motor-driven Powerstat variable transformers of the 116, 117, 216, 217, 126, and 226 series. Smaller, lower-priced assemblies can now be used in remotely controlled applications where the motor-driven variable transformer is installed in any out-of-the-way space and the push-button or raise-lower switch placed wherever desired. Units use the new Type SS50 Slo-Syn synchronous motor for driving. Smooth, quiet planetary-gear reduction assemblies provide speeds of 5, 15, 30, or 60 sec for full-range travel from zero to maximum output voltage. For complete information request four-page Powerstat Flyer SE-L2609 from Superior Electric Co. —K–21

OUTSTANDING PERFORMANCE

BARCO ROTARY JOINTS

Shown at the right is an installation of ¾" Barco Type C Rotary Joints on a 9" dia. calender roll stack. Every other roll is equipped to be steam heated and syphon drained at 125 p.s.i., 300°F. The rolls run at a paper speed of 1300 FPM, or approximately 450 RPM. The joints have been in service for many months with no difficulties experienced.





Patent No. 2,836,439

TYPE C

Single Flow or Syphon Flow

- RESISTS SEAL RING BREAKAGE—The spherical seal ring is under compression, not tension, loading. Self-adjusting for wear. Seal withstands shock loads and alternating hot and cold service.
- WIDE SPACED BEARINGS—Two, instead of one . . . increased bearing area. No lubrication required. Lowest friction.
- 200 P.S.I. STEAM RATING—Heavy duty service at no extra cost. Eight sizes, ½" to 3".

SEND FOR CATALOG 310

HERE is another case (*above installation*) where an experienced user of rotary joints made comparative tests. Two other makes of joints were tried and Barco selected.

"*Last longer without maintenance!*" reports the user. When properly installed, Barco Joints easily withstand rugged service on paper calenders, machines, and other mill equipment.

Barco Type C Joints are available from LOCAL STOCKS throughout the country. Standard series joints handle all steam pressures to 200 psi—one basic style for all services, single flow or syphon flow. *Type CF offered for journal flange connections. ASK FOR INFORMATION.*

FOUNDED 1920 BARCO PRODUCTS BACKED BY EXPERIENCE

BARCO MANUFACTURING CO.
521L Hough Street, Barrington, Illinois
The Only Truly Complete Line of Flexible Ball, Swivel, Swing and Rotary Joints
In Canada: The Holden Co., Ltd., Montreal

KEEP INFORMED

NEW EQUIPMENT BUSINESS NOTES LATEST CATALOGS

Chuck Jaws

A complete line of soft blank top jaws in sizes and shapes for all chucks made to American Standards has been announced by Skinner Chuck Co.

Included in the line are medium and heavy-duty types in standard, extra-high, and long pointed-jaw construction for tongue-and-groove mounting. In the medium-duty line, top jaws for chucks 18 in. and larger are interchangeable with the heavy-duty type.

Skinner also offers soft blank top jaws and master keys for mounting on serrated master jaws for heavy-duty power and scroll chucks.

The top jaws can be used as supplied or shaped to meet specific requirements. They are manufactured from low-carbon steel which can be easily carburized and hardened. All soft blank top jaws are furnished in black, and are processed to resist rust. Hardening instructions are included with the jaws.

A new brochure describing the complete line of soft blank top jaws is available from Skinner distributor's stock and from the company. **—K-22**

Pyrometers

Several special types of pyrometers for the measurement of temperatures above 3000 F are now offered commercially by Atlantic Pyrometers, Inc. These do not use thermocouples and have no problems of atmosphere limitations, calibration drift, and short life.

The principal applications are for such research and laboratory applications as radiation heat-transfer studies, high-temperature material investigations, and engine and burner studies.

For the measurement of the temperature of "gray" flames by the Schmidt Method single and double-beam radiation pyrometers and accessory equipment are offered.

For the measurement of hot gas temperature, venturipneumatic pyrometers along with auxiliary computing and recording equipment are supplied.

For the measurement of gas temperatures below 3000 F where radiant transfer to or from surrounding walls would make errors with ordinary thermocouples unacceptable, suction pyrometers are supplied. **—K-23**

Toggle Switch

A four-way toggle switch has been added to the Haydon Switch Inc., line of toggle-actuated switches.

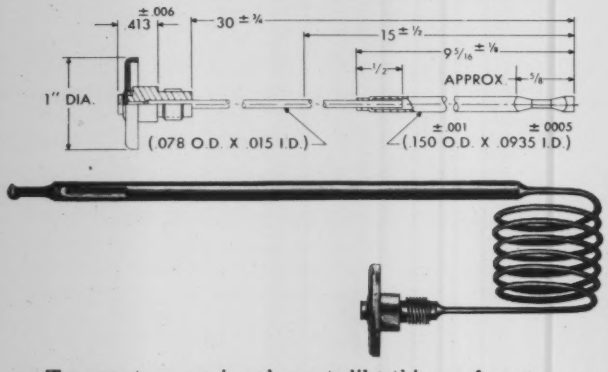
The No. 53574 toggle switch has 8-pole, double-throw contacts. The assembly is made up of four pairs of Series 5300 snap-action switches, with electrical ratings at 5 amp resistive, 3 amp inductive, at 30 volts d-c and 115 volts a-c. From the center position it is possible to actuate double-pole double-throw circuitry in each of the four momentary positions spaced 90 deg apart. Dimensions: $2^{3}/_{32}$ in. high × $1^{29}/_{64}$ in. Weight is 0.11 lb max. Operating force is 0.5 lb.

Easy and assured operation is attained because the basic snap-action switches are in the same plane as the bat handle, thus giving direct action.

Application: This four-way toggle switch is designed for an aircraft navigational system, and may be used in similar applications such as radar, fire control, and aircraft trim control. **—K-24**

TEMPERATURE SENSOR

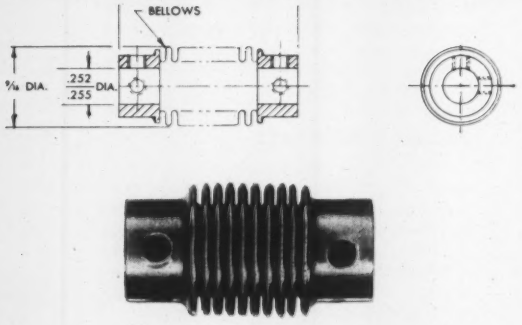
ACCURATE, NO-DRIFT CONTROL FOR APPLIANCES SOLVED BY ROBERTSHAW DIASTAT® ASSEMBLY



Temperature sensing elements like this one for a range oven control offer permanent accuracy with no drift, consistent calibration, no resetting, long life and savings in space, weight and unit cost. Ambient temperature sensing devices are unnecessary in most applications. Typical stroke is .035" for a 1" diameter stainless steel diaphragm. Ideal for sensing temperatures up to 650°F. All units are custom engineered and delivered as pre-assembled "packages," tested and ready for mounting. **WRITE FOR BULLETIN D-6010**

FLEXIBLE COUPLING

ELIMINATE BACKLASH, END-PLAY! ABSORB VIBRATION, SHOCK WITH ROBERTSHAW FLEXIBLE COUPLINGS



Servomechanisms, instruments and similar drive and control systems are the big users of these small, flexible units. Ideal for guarding against misalignment friction and bearing wear problems. Save space and weight. Cut down noise. Simplified design utilizes seamless metallic bellows, in choice of several metals, connected to two hubs. Sizes from $^{15}/_{32}$" O.D. Stock sizes accommodate shafts from ⅛" to ½". Other sizes custom-engineered. **WRITE FOR DATA SHEET D-8010**

KEEP INFORMED

NEW EQUIPMENT
BUSINESS NOTES
LATEST CATALOGS

Slip Clutch

Dynamic Gear Co. has designed and developed a slip clutch which eliminates galling and also maintains more uniform slipping torque. Over-all length of the unit is only 0.800 in.

The slip clutch has application as a safety device in expensive, complex gear trains. Installed in the train as a tensioning device, the unit will slip should output rotation be interrupted due to jamming or overloading.

The Dynaco slip clutch can be set to a predetermined torque value and will maintain this value even after extended periods of slipping. Conventional-type slip clutches, after periods of prolonged slippage, have a tendency to gall at two specific points with resultant binding and damage to the gear train. On conventional slip clutches, the friction plate consists of a gear revolving on a bronze center member. The Dynaco slip clutch has this gear mounted on a ball bearing so that even after long periods of slippage, no galling will occur. The friction plate proper is made of DuPont Delrin which offers greater uniform slip torque. The other point of galling on conventional units is where the spring bears on the clamp. The Dynaco slip clutch utilizes a No. 303 stainless-steel bushing which eliminates galling at this critical point.

Units are offered in a diametrical pitch of 48, 64, 72, 80, 96, and 120. Pitch diameters are from 0.750 through 2000 in. with pressure angle of 14½ or 20 deg. —K–25

C-Press

A C-Press with Hydraulic Index Table is made in 5, 10, and 15-ton models with 6, 8, or 12-station tables by Hydraulic Press Mfg. Co. The operator is safely away from the press ram, and loads parts in comfort with no waiting. As many as three operators can perform assembly or other functions around the small table. Automatic air ejection speeds production. Die blocks on holding fixtures are located at six stations. —K–26

Bench Scales

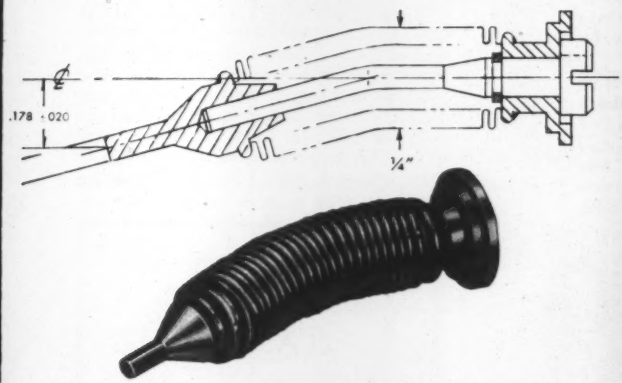
A new line of platform-type bench scales for heavy-duty general-purpose weighing operations is available from the Exact Weight Scale Co.

Type 9600 scales are specially designed to provide continued accuracy under conditions of prolonged industrial usage. They are engineered with a minimum of moving parts for maintenance-free operation. Overload and bumper springs guard against excessive shock in loading and unloading. An adjustable hydraulic dashpot controls weighing speed over a wide range for fast accurate performance.

Scales in any of four different capacities are available—50-lb with 1-oz graduations, 100-lb with 2-oz graduations, 200-lb with 4-oz graduations, and 300-lb with 8-oz graduations. The completely sealed no-glare dial chart has a 20¼-in. over-all diam, a 15-in. diam reading line, and large black figures for easy reading. Parcel-post dial charts are also available. —K–27

MINIATURE BELLOWS

SAVE SPACE AND WEIGHT WITH RUGGED, MINIATURE ROBERTSHAW FORMFLEX* BELLOWS



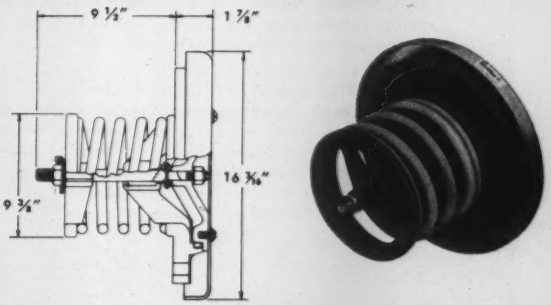
Now . . . hydraulically formed seamless metallic bellows as small as ⅛" O.D.! These miniature Formflex units, along with ¼" and 5/16" O.D. sizes, permit further miniaturization in aircraft, missiles, instruments and other equipment. All sizes are available in a wide range of metals to provide the desired strength and performance characteristics. Ideal in assemblies that react to or compensate for pressure and temperature changes. *Custom*-engineered in any quantity you may require.

WRITE FOR BULLETIN D-1010

*Registration pending

PRESSURE RELIEF VALVE

VENTS PRESSURE BUILD-UP IN TRANSFORMERS, TANKS . . . RESEALS AUTOMATICALLY WITH NO RESETTING!



Now you can forget breakaway seals that have to be replaced each time dangerous high pressure build-ups are relieved. Robertshaw Pressure Relief Valve operates instantaneously. No moisture or contaminants can enter vessel during blow-off or automatic resealing and resetting. No periodic inspections necessary.

WRITE FOR ENGINEERING DATA SHEET D-9010

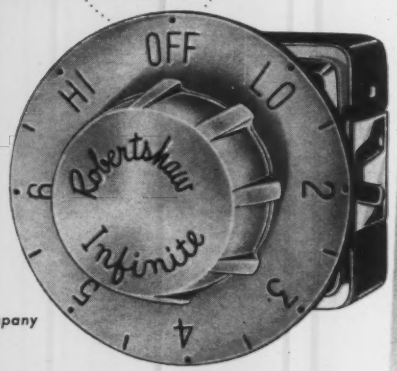
Robertshaw

BRIDGEPORT
THERMOSTAT DIVISION
ROBERTSHAW-FULTON CONTROLS CO.
Milford, Conn.

Chace
THERMOSTATIC BIMETAL
ACTUATES ANOTHER PRECISION PRODUCT...

Robertshaw
MR. CONTROLS

Electric Infinite Control



A product of Robertshaw-Fulton Controls Company Indiana, Pennsylvania

Range manufacturers wax enthusiastic over this new development from Robertshaw. And well they might, because this is one Infinite Control designed with the manufacturer in mind! For instance: the new model INF (pictured) is approximately the same size as an ordinary five-heat rotary switch, making it fully interchangeable at any time in the production cycle. The range builder needs to stock only one type control for all elements.

The Robertshaw Electric Infinite Control model INF turns clockwise or counterclockwise and is equipped with three indexing positions: "Off," "High," and "Low." In the "High" position, the control is energized continuously. At other settings it delivers the selected input level under the control of a bimetal timer. A second bimetal is employed as an ambient temperature compensator to neutralize the effect of ambient temperature changes on the control bimetal. *Both* of these important components are made of Chace Thermostatic Bimetal.

By specifying the inclusion of Chace Thermostatic Bimetals in "the most advanced concepts in electric controls," Robertshaw joins many manufacturers who know they can depend on Chace. This dependability is born of more than 30 years of manufacturing only one product: precision bimetal. Any manufacturer can be sure his name is safe on the outside with Chace Thermostatic Bimetal on the inside of his product.

OUR NEW INFORMATION BOOKLET IS READY NOW!

If your new product is approaching the design stage, send for "Information Booklet". It contains design data, illustrations and applications for more than 30 types of Chace Thermostatic Bimetal. Chace bimetal is available in stripes, coils and in completely fabricated elements of your design.

IT BENDS WITH THE HEAT

W. M. CHACE CO.
Thermostatic Bimetal
1619 BEARD AVE., DETROIT 9, MICH.

KEEP INFORMED

BUSINESS NOTES
NEW EQUIPMENT
LATEST CATALOGS

Insulating Fill

Perlox, a low-cost, low-density insulating fill, specially suitable for use with low-temperature liquified gases is available from Johns-Manville. Formed from expanded silica aggregate, it offers the maximum thermal resistance at a minimum cost, according to the company, yet is completely safe for the majority of cryogenic applications, including insulating liquid oxygen and liquid hydrogen.

A completely inorganic material, it is both physically and chemically stable, and because of its structure and powder form, provides very little body for moisture pickup. When the material is settled in place it has a density of only 3 lb per sq ft. Temperature limits for Perlox are from − 450 F to + 1400 F. At − 300 F it has a thermal conductivity of slightly less than 0.10 Btu in. per sq ft per deg F per hr. It is available in loose powder form, packed in paper bags. **—K–28**

Portable Test Instrument

All materials such as metal, plastics, textiles, wire, springs, and leather, can be easily tested with the Dillon Model M tester. Simple changes in grips quickly adapt the basic instrument for tests of tensile, compression, transverse, and shear forces.

Operation of the unit is by means of a calibrated pendulum—one of the most accurate of all measuring devices. All testers are guaranteed accurate within $\frac{1}{2}$ of 1 per cent of indicated reading in accordance with ASTM requirements.

Wide flexibility is provided by the five ranges, from 0–10 to 0–300 lb, combined on the one 8-in dial. Calibration is available in a choice of ounces, tenths of pounds, or kilos. Permanent stress-strain curves are also possible with the unique Dillon rotating-drum recording system as an accessory.

Model M testers are available with manual handwheel, or motorized and can be converted from manual to motorized, at any time, with a Dillon motorization kit. Also supplied with built-in controlled-temperature cabinets with working ranges from room temperature to 400 F.

Data available from George A. Dillon, W. C. Dillon & Co. **—K–29**

Use a
CLASSIFIED
ADVERTISEMENT
for Quick Results

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BUSINESS NOTES
NEW EQUIPMENT
LATEST CATALOGS

Bolt

A high-strength bolt has been designed with larger head and shorter thread length by Russell, Burdsall & Ward Bolt and Nut Co.

Savings up to 40 per cent in bearing-type connections over present high-strength bolts are made possible by the new head and thread design which has been approved by the research Council of Riveted and Bolted Structural Joints and by the American Institute of Steel Construction.

The increased bearing area will permit developing the full clamping force of the bolt without using a washer under the head and without brinnelling of the work. The bolt can be stressed to 85,000 psi or more without a washer. —K–30

Self-Locking Nuts

Added performance and reliability in high-temperature applications are provided by a new 1000-F, 145,000-psi self-locking nut from Standard Pressed Steel Co.

Called the FN 1014 featherweight locknut, it significantly exceeds tensile-strength, maximum-usage-temperature, magnetic-permeability, and locking-torque requirements of the aerospace industry's NAS 1291C nut standard.

In addition, the FN 1014 is said to be the lightest locknut available for its rated strength and temperature.

In comparison with minimum NAS 1291C requirements, it is rated at 145,000 psi axial tensile strength, rather than 125,000 psi. Temperature ceiling is 1000 rather than 800 F. Corrosion resistance is rated as excellent at temperatures up to 1000 F.

The FN 1014 has a lower permeability—1.1 oersteds compared to the NAS 1291C standard's 2.0 oersteds. And the new nut is rated for locking torque on the basis of 15 separate seated applications at an induced bolt stress of 75,000 psi rather than on the basis of 15 unseated applications.

The FN 1014 has a reduced-height hexagonal wrenching area designed for minimum mass. The new nuts weigh considerably less than either NAS 679C or AN 363C series nuts. Efficient design also provides substantial structural space savings.

The FN 1014 nuts are forged from A-286, heat and corrosion-resistant alloy, and are silver-plated to AMS 2410 standards. Integral self-locking feature provides a three-point positive lock.

FN 1014 locknuts can replace NAS 679C, NAS 1021C, NAS 1022C, AN 363C, and other similar nut series.

An alternate series, designated FN 1014M, finished with a molybdenum-disulfide dry-film lubricant instead of the silver plate, is also being made available for moderate temperature usage.

Both FN 1014 and FN 1014M series nuts are made in standard Class 3B sizes ranging from No. 4-40 through $^3/_8$-24. —K–31

More equipment manufacturers choose Fast's Couplings than any other gear-type coupling

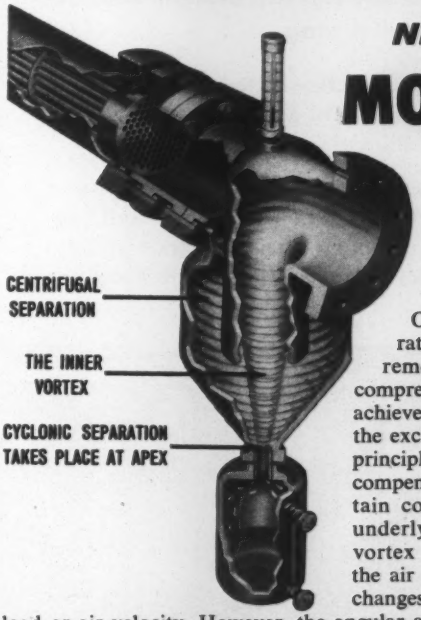
Leaving other claims aside, the thing that counts in couplings is customer confidence—and industrial equipment manufacturers have made Fast's their overwhelming choice. The Fast's line is more diversified, too—in a complete range of sizes and types for shafts, from ½" to 32" and larger.

Every Fast's Coupling brings you superb engineering only the original gear-type coupling can deliver. Smooth-running units that are designed to outlast the machines they connect. Rapid service from experienced field engineers backed by outstanding stock facilities. Write today for full details on couplings to suit your needs to: KOPPERS COMPANY, INC., Fast's Coupling Dept., 510 Scott St., Baltimore 3, Maryland.

KOPPERS

FAST'S COUPLINGS

Engineered Products Sold with Service



NEED BETTER

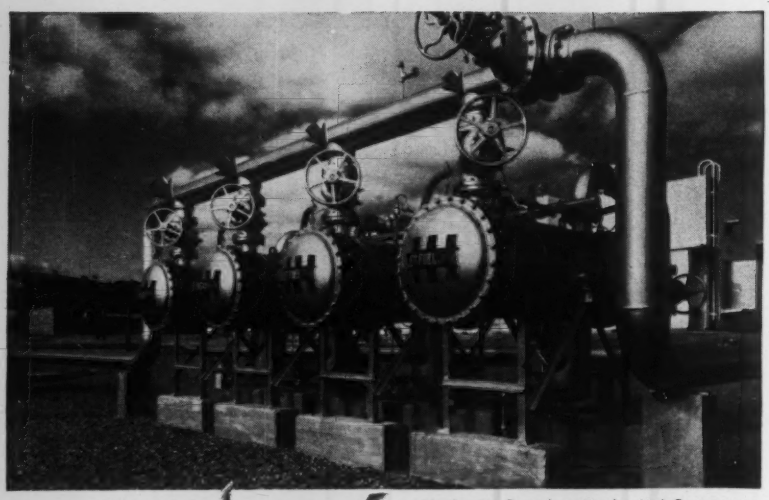
MOISTURE AND OIL REMOVAL?

(for your compressed air system)

Only the Adams CYCLONE Separator assures peak efficiency in the removal of oil and water from your compressed air system. Top operation is achieved from one-quarter to full load by the exclusive cyclone design. It is a proven principle of operation which automatically compensates for variation in load to maintain constant separating efficiency. The underlying feature is the inner cyclonic vortex formed within the unit itself by the air stream. The diameter of the vortex changes in proportion to variations in the load or air velocity. However, the angular air velocity, the RPMs, remain constant — and it is the angular velocity — the infinite changes of direction, which effect the separation of entrained particles at practically constant efficiency.

Remember, your aftercooler is only as effective as the separator which removes the condensed oil and water. Find out today how the Adams design can improve your oil and moisture removal efficiency. Write today for your copy of Bulletin 714.

R. P. ADAMS CO., INC. 204 EAST PARK DRIVE BUFFALO 17, NEW YORK



Markowitz Bros. Inc., Mechanical Contractors
Miami, Florida

on the military pipeline in spain...

WELDOLETS were used for all branch connections on pumping station piping

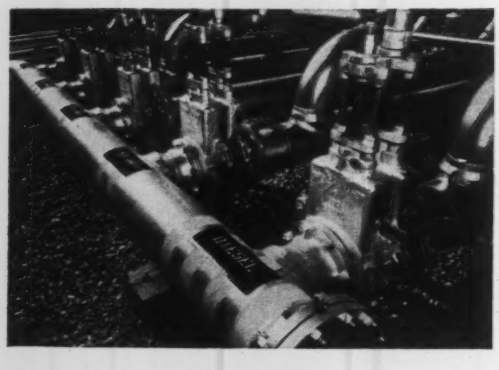
Reinforced branch connections constructed with Weldolet Welding Fittings provide assurance of quality workmanship at the critical branch connection.

Savings in purchase price and construction on this project alone were high in the six figures. Piping designers and contractors who are interested in similar savings on their jobs are invited to write us for the Bonney Spanish Pipeline Brochure.

BONNEY

WELDOLETS®
THREDOLETS®
SOCKOLETS®
ELBOLETS®
BRAZOLETS®
SWEEPOLETS®

CARBON STEEL
STAINLESS
ALLOY
for all services



BONNEY FORGE and TOOL WORKS
ALLENTOWN, PENNSYLVANIA

KEEP INFORMED

BUSINESS NOTES
NEW EQUIPMENT
LATEST CATALOGS

Circuit Breakers, Switchgear

A completely new design of 4160-volt circuit breakers and switchgear—first clean-sweep redesign of equipment in this voltage rating—has been announced by the switchgear division of I-T-E Circuit Breaker Co.

The breakers, first to combine stored-energy closing and ironless blowout in this voltage rating, afford faster fault interruptions and faster closing of contacts, and smaller size.

The result of the redesign is a major advance in the industry in terms of greatly improved fault protection, increased safety for personnel and equipment, higher reliability, easier handling; and much simpler installation, maintenance, and service.

The types of switchgear construction available include the conventional indoor arrangement, and two types of outdoor configurations—standard enclosed and full walk-in. **—K-32**

Alarm Rotameter

A line of Alarm Rotameters made by the Instrument Div., of Schutte & Koerting Co. is designed to measure fluid rate of flow and to indicate abnormal high or low flows.

They can be made to activate a warning light or alarm device, and will start or stop a pump, motor, or control unit. Their design and construction is simple making them economical and easy to maintain.

A typical unit consists of a standard 5-in. scale glass-tube or metal-tube Rotameter and a sensing system which is mounted above the Rotameter in a weather-proof extension housing. This type unit uses a float extension rod with an encapsulated magnet. The rod extends up into a stainless-steel housing tube. One or two sensing devices (switch assemblies) are mounted on the housing tube. Each unit contains a magnet and an hermetically sealed reed-type alarm switch which activates a high or low-flow alarm or "start-stop" switch.

Either one or two sensing devices are set for maximum and/or minimum flows desired. Flows above or below these settings are considered abnormal. When flows are within the range desired, the encapsulated magnet in the extension rod will rise or fall with the float but will do so in the range between the sensing devices. During normal flow conditions, the switch contacts are closed, keeping the relay coil energized and the alarm circuit open.

When flow is higher or lower than that for which the sensing devices have been set, the magnet in the extension rod will pass either the high or low sensing device. In doing so, it interrupts a magnetic circuit within the alarm switch caused by the field of the biasing magnet. This causes the switch contacts to open which, in turn, opens or closes the alarm circuit through the relay. **—K-33**

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MECHANICAL ENGINEERING—OCTOBER 1960—Products Advertised

1	16, 17	28, 29	40	153	165TL	174R	185	192
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4	19	32	144	156	167L	176L	189	203
6, 7	20, 21	33	146	157T	168	176R	190TL	204
8	22	34	147	157B	169T	177L	190BL	IFC
9	23	35	148	158	169B	177R	190TR	IBC
10, 11	24	36	149T	161	170	179	190BR	OBC
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K-2	K-13	K-24	K-35	K-46	K-57	K-68	K-79	K-90
K-3	K-14	K-25	K-36	K-47	K-58	K-69	K-80	K-91
K-4	K-15	K-26	K-37	K-48	K-59	K-70	K-81	K-92
K-5	K-16	K-27	K-38	K-49	K-60	K-71	K-82	K-93
K-6	K-17	K-28	K-39	K-50	K-61	K-72	K-83	K-94
K-7	K-18	K-29	K-40	K-51	K-62	K-73	K-84	K-95
K-8	K-19	K-30	K-41	K-52	K-63	K-74	K-85	K-96
K-9	K-20	K-31	K-42	K-53	K-64	K-75	K-86	K-97
K-10	K-21	K-32	K-43	K-54	K-65	K-76	K-87	K-98
K-11	K-22	K-33	K-44	K-55	K-66	K-77	K-88	

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KEEP INFORMED

BUSINESS NOTES
NEW EQUIPMENT
LATEST CATALOGS

Vibrating Feeders

A new principle of vibration is incorporated in the Link-Belt Co. Straightline vibrating feeders used for high-capacity controlled feeding of ore, coal, rock, shale, slag and other heavy and highly abrasive bulk materials.

The straight-line high-intensity feeding motion of the Synchromatic vibrator mechanism is produced by the vibrator's two unbalanced shafts each driven by a rugged individual pancake motor mounted directly on the vibrator frames. The shafts rotate in opposite directions and cause the motors to synchronize despite absence of direct coupling between shafts.

The combination of speed, stroke intensity, and straight-line action are said to result in effective feeding regardless of the type of material being handled. The Straightline vibrating action and resulting conveying action of the feeder can be altered by changing the amount of shaft unbalance.

Two models in 30 sizes are available with capacities up to 1350 tons per hr. The feeders are low in first cost, easy to maintain and are shipped as complete units, making field assembly unnecessary. They contain a minimum of moving parts and all bearings, shafts, and structural parts are enclosed for protection against shock loads. The new feeders can be installed in low-head-room areas and require minimum maintenance. Material in the feeder trough is handled without spillage, leaks or carry-over. —K-34

Threaded Union

Addition of a threaded union to the line of Braze-lok tube fittings is announced by Fittings & Hose Div., Parker Hannifin Corp. The Braze-lok fitting, with a prepositioned brazing ring inside the socket, provides a semipermanent, brazed tubing joint to assure nonleak connections for high-pressure and other critical service.

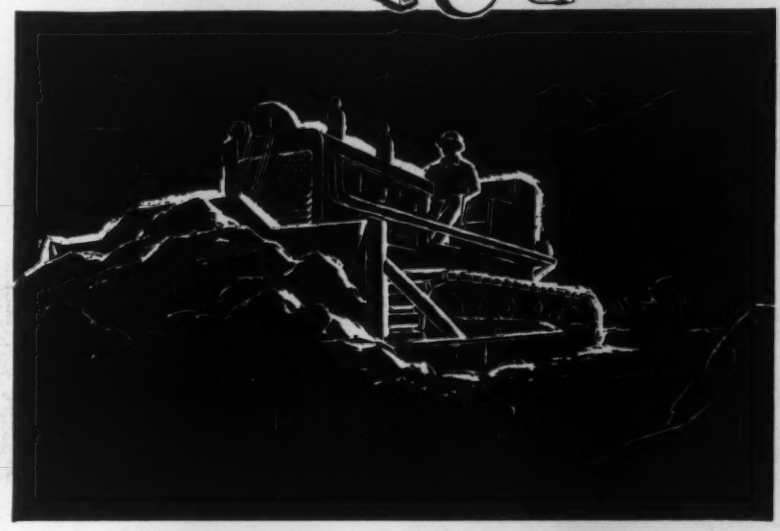
The new union is offered in response to the demand for a disconnectable joint in Braze-lok fitted circuits. The union consists of two parts, each of which has the Braze-lok socket for brazing to the tube. One part has the SAE hydraulic 37-deg flare cone (as used by the Triple-lok tube fitting) while the other part has a swivel nut to mate with the straight threaded cone to provide a metal-to-metal seating.

The two-piece union is offered in steel and stainless steel, for tubing from 1/4 through 2 in. OD. —K-35

For Consulting Engineers

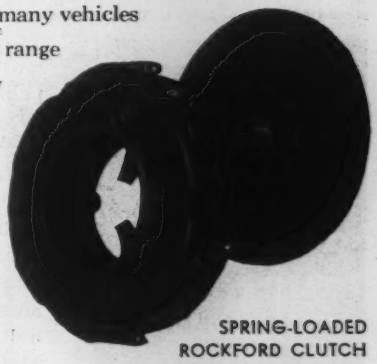
Turn to Page 200

from MIDGET CARS . . .



to MIGHTY CRAWLERS

Both are driven by Rockford Spring-Loaded Clutches. These versatile power-links drive many vehicles of all types and sizes. Torque loads range from 50 to 2,530 ft. lbs.! Sizes vary from the compact 6" clutch to the powerful 16" double plate unit. Positive, full-motion driving power with smooth starts and controllability is yours with Rockford Clutches. Write today for illustrated brochure.



SPRING-LOADED ROCKFORD CLUTCH

ROCKFORD CLUTCHES

ROCKFORD CLUTCH DIVISION BORG-WARNER

1307 EIGHTEENTH AVE.
ROCKFORD, ILLINOIS

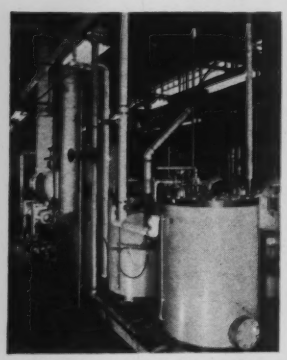
Export Sales
Borg-Warner International
36 So. Wabash, Chicago, Ill.

At Caterpillar Tractor Co. . . .

4 new Lectrodryers boost supply of controlled atmosphere to 60,000 cfh

Heat treating furnaces at Caterpillar Tractor Co., Peoria, Illinois, draw on a central source of controlled atmosphere gases for annealing, brazing, carburizing and other metallurgical operations. Five Lectrodryers are now drying 30,000 cubic feet of gas per hour; four more Lectrodryers are being added to almost double the capacity.

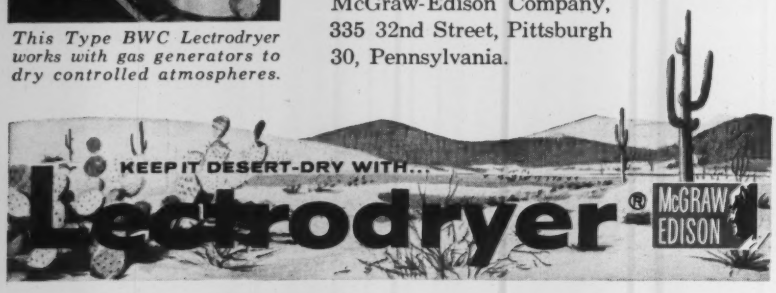
Manifolding the output of several gas generating units gives the flexibility required to service Caterpillar's many controlled atmosphere furnaces. Where those atmospheres must be dry, Lectrodryers lower dewpoints to −20°F.



This Type BWC Lectrodryer works with gas generators to dry controlled atmospheres.

Your gas generator builder

can advise you on equipment for supplying controlled atmospheres. Where dry gas is required, he'll quite likely supply Lectrodryers. *For data sheets* on metallurgical gas drying installations, or for answers on any other drying problems, write Pittsburgh Lectrodryer Division, McGraw-Edison Company, 335 32nd Street, Pittsburgh 30, Pennsylvania.



KEEP INFORMED

BUSINESS NOTES
NEW EQUIPMENT
LATEST CATALOGS

Liquid-Air-Separation Plant

Armco Steel Corp. and Air Reduction Co. have placed on stream Airco's newest "on site" liquid air-separation plant. At capacity, 120 tons of high-purity oxygen per day, will be supplied by pipeline directly to the Butler Works of the Armco Steel Corp. The multi-million-dollar, electronically controlled facility, will also produce quantities of nitrogen and liquid argon.

Armco will use the oxygen to increase the combustion capacity of open-hearth steel furnaces and as a direct oxidizing agent to remove impurities from the molten steel in both electric and open-hearth furnaces.

Oxygen will also be used at Armco for scarfing of slabs to remove surface defects before rolling, as well as for general plant maintenance. The nitrogen will be used as an inert blanket principally for the prevention of oxidation during the annealing of silicon steel.

The newest Air Reduction facility at Butler is one of four tonnage liquid-air-separation plants at that site. The gases produced at the plants are distributed over an area with a 500-mile radius. **—K–36**

Pressure and Liquid-Level Transmitter

The Model P pressure and liquid-level transmitter, an inexpensive yet rugged instrument capable of measuring pressures as high as 250 psi or ranges from as low as 0 to 100 in. of water has been announced by Conoflow. Operating on the simple force-balance principle, the Model P transmits a linear 3 to 15-psi signal to any standard receiver element.

The measuring diaphragm is completely separated from the pneumatic pilot which prevents process liquids and gases from backing up into air lines and damaging costly instruments. No dip tubes, floats, or other mechanical devices are required inside the tank; only the corrosion-resistant Inconel-X diaphragm is exposed to the measured material. The Model P can be mounted either horizontally or vertically on both open and closed tanks.

For more information request Bulletin P-36-1 from Conoflow Corp. **—K–37**

Needle Valves

Precision-machined, precision-ground needle valves made by Marshalltown Mfg. Co., are machined from high-grade carbon-steel bar stock or 416 stainless steel for hydraulic service where many corrosive liquids are used. Each valve is precision machined to provide perfect alignment of stem and seat. Female pipe threads at both ends are longer than standard to assure tight fit on undersized pipe. All needle valves are designed to withstand pressures up to 10,000 psi at 70 F. Special packing will withstand 550 F. Die-cast alloy handle is designed for heat dissipation and ease of operation.

—K–38

CASH-ACME . . . meeting pressure control needs for product design engineers everywhere

CASH-ACME VACUUM REGULATOR VALVE PREVENTS CIGARETTE JAM IN NEW FILTER TIPPING DEVICE

To keep pace with fantastic demands for filter tipped cigarettes (now 40% of the market), manufacturers are attaching a new kind of tipping device to machines —capable of tipping 780,000 cigarettes in a 10-hour run

Designers give a lot of credit for the device's amazingly foolproof performance to Cash-Acme engineers An extremely exact "low whisper" vacuum must be maintained at all times... just enough to hold the cigarette while the filter is affixed. This is assured by strategic placing of Cash-Acme Regulator Valve D-51 on the machine's vacuum line which brings high vacuum from the plant's central system. By regulating and keeping the vacuum at the proper level, all chances of "jamming" and production loss are eliminated.

TYPE D-51 VACUUM REGULATING VALVE Ready for exacting vacuum regulating jobs on any type of equipment. Type D-51 is expressly designed for use in systems where it is desired to maintain, automatically, a lower vacuum at the valve inlet than prevails at the source on the valve outlet. No step-action, no snap-action, but full-floating and automatic.

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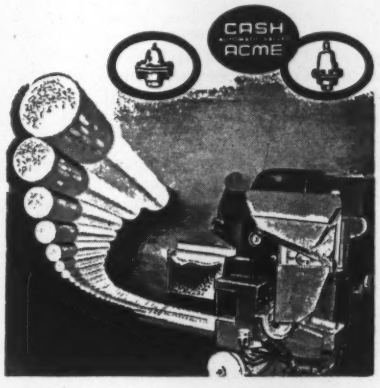


KEEP INFORMED

BUSINESS NOTES
NEW EQUIPMENT
LATEST CATALOGS

Squirrel-Cage Motors

A new line of large squirrel-cage motors, 250 through 1000 hp, is announced by Wagner Electric Corp. Built for heavy-duty industrial applications, these motors feature extremely compact, smoothly contoured, fabricated-steel-plate enclosures that have great mechanical strength and high resistance to corrosion. For safety and ease of handling, four lifting eyes are built-in as integral parts of the frame ends. Mounting space required is materially reduced by positioning the feet under the overhang of the frame.

The flat steel endplates are built in two sections, facilitating disassembly for bearing inspection, if required.

The enclosure is completely drip-proof with ventilating openings so located and shielded as to provide essentially splash-proof protection.

Preformed coils of copper strip are precisely shaped to make up the uniform, well-braced winding. Coil ends and lead connections are permanently brazed. The insulation system is carefully balanced to give mechanical and electrical strength with good resistance to heat, moisture, and aging.

Both the stator and rotor core are constructed to permit radial as well as transverse circulation of air for efficient dissipation of heat.

Available voltages are 440, 550, 2300, and and 4160 volts, 60 cps. The entire range of ratings, 250 through 1000 hp, can be supplied with full load speed of 3500, 1750, or 1160 rpm; 870 and 690-rpm motors are available through 700 hp, and 575-rpm motors through 500 hp.

Sleeve-bearing models can be furnished in the entire range of ratings and speeds; ball-bearing models through 400 hp, all speeds, and through 900 hp at some of the lower speeds. —K–39

Cutting Tools

Four new catalogs have been issued for the Cutting Tool Div., Brown & Sharpe Mfg. Co.

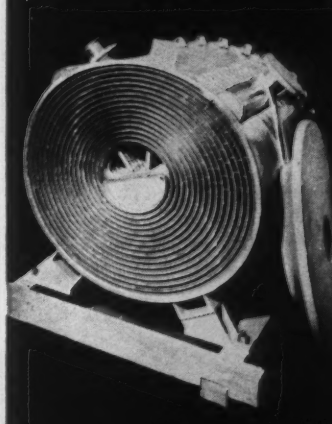
General Catalog No. 38 is divided into two separately bound catalogs, one for high-speed steel-and-carbide end mills and one for high-speed steel-and-carbide milling cutters. In addition, a separate, complete catalog of Nelco solid-carbide and carbide-tipped end mills and cutters is available.

Each catalog contains the following information for each tool: tool-design data, tool tolerances, tool features, materials to cut, production uses, and dimensional drawings. There are sections in each catalog to help the user buy special tools, sections on speeds and feeds, tool-selection tables, and engineering data on resharpening most tools.

Request No. 38E for 52 pages on end mills, No. 38C for 40 pages on milling cutters, No. 38N for 36 pages on carbide tools, or No. 38 for the complete 128-page General Catalog. —K–40

TO BE "HOT" ON

HEAT TRANSFER



For better answers to questions about heat transfer equipment, how present power-production methods compare with Magneto HydroDynamics, how greater efficiency than today's 40% can be achieved—visit the Power Show.

The answers are easier, and your job potential better when you've seen the latest in such heat exchanger equipment as condensers, intercharges, feed water heaters, intercoolers, preheaters, after coolers—PLUS a broad line of other power and allied equipment.

Only at the Power Show do you have the opportunity to investigate, compare and get the right answers, face-to-face, from the manufacturers themselves. Only at the Power Show can you see over 250 leading suppliers' products, all conveniently grouped together at one time.

Make sure you're there. Everyone else will be!

2450

24th NATIONAL EXPOSITION OF POWER & MECHANICAL ENGINEERING

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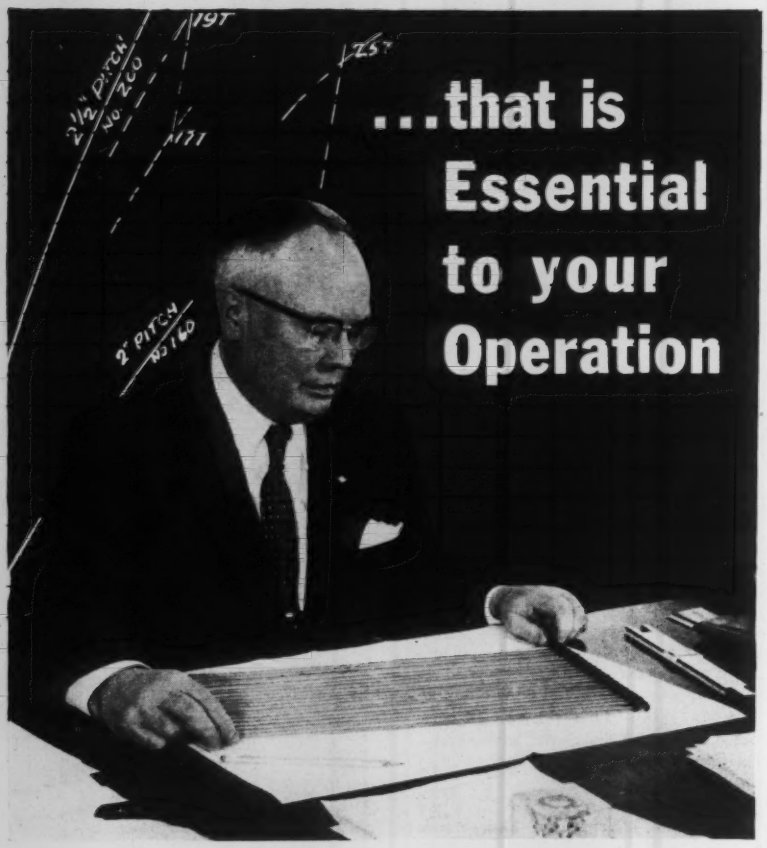
NEW YORK COLISEUM

NOV. 28—DEC. 2, 1960

MANAGEMENT: INTERNATIONAL EXPOSITION COMPANY
480 Lexington Ave., New York 17, N. Y.

Here's Engineering Service...



– and it's part of *ACME'S* Basic Policy

Whether it's technical advice or field assistance, it has always been and will continue to be part of Acme's Basic Policy to make "all the knowledge and assistance of their Engineering Department" available to help manufacturers solve their problems.

Acme Engineers will be glad to advise you as to chain size and selection that may save you both time and money. For any problem involving roller chains, don't hesitate to consult with your Acme Distributor or to call or write our Engineering Department for assistance.

Acme Chain Corporation
HOLYOKE MASSACHUSETTS

Write Dept. 11-G for new ill. 100 page catalog with engineering section.

RELIABLE CHAIN DRIVES FOR ALL INDUSTRIES

ROLLER CHAINS, SPROCKETS, CONVEYOR CHAINS, FLEXIBLE COUPLINGS, ATTACHMENTS. (Special and Standard)

KEEP INFORMED

BUSINESS NOTES
NEW EQUIPMENT
LATEST CATALOGS

Air Conditioner

A low-silhouette air conditioner made by the Modine Mfg. Co. is likely to trigger a whole trend in fan-coil thinking. The new unit, called Low-boy Airditioner, is only $14^1/_2$ in. high, about half the height of standard fan coils units.

It was designed by Modine engineers to permit fan-coil units rather than central-duct systems in multistory buildings featuring floor-level fenestration or low windows.

The cooling and heating unit is located at the center of the window base, conditioned air blankets the window exposure, off-setting heat gain or loss and maintaining desired temperatures.

The Low-Boy is a fan-coil unit, utilizing two small-diameter pipes and a condensate drain and is fed hot or chilled water from a central source. The pipes, condensate drain and electrical-service lines are all located above the floor and generally are concealed by enclosing them within an inexpensive metal cover or chase.

The simple piping required eliminates the need for expensive ducting with subsequent reduction of floor build-up, an important cost factor. The basic unit is also ideal for air conditioning existing buildings with only the addition of simple, direct piping and no "rip-outs."

Another feature of the unit is its individual room control. **—K–41**

Machine Mount

A highly efficient machine mount using specially processed, high-density fiberglass has been announced by Consolidated Kinetics Corp. The Model N kinetic mounts isolate vibration and eliminate the need to lag-down machinery.

Guaranteed not to "creep," this new product permits mobile rather than permanently installed production machinery for the most efficient work-flow.

Kinetic mounts utilize the extreme elasticity of the glass fibers, resulting in outstanding isolation efficiency plus high internal damping for machine stability. Elimination of chatter in precision machines caused by externally-excited vibration is now possible. Impact and shock loads present in punch presses and similar equipment are also effectively isolated.

The Model N kinetic mounts are used where built-in level control is not required. The previously announced Model L kinetic mounts are equipped with built-in level control. Both models are available in three standard sizes to handle load ranges to 8000 lb per mount.

By elimination of lag screws and special foundations, up to 90 per cent savings in installation or relocation of machinery are obtained, the company states. **—K–42**

TANK-O-METER

FOR MEASURING TANK CONTENTS ANY DISTANCE AWAY

TANK MAY BE BURIED, ELEVATED, OPEN, CLOSED, VENTED OR UNDER PRESSURE OR VACUUM

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LABOR CALCULATOR BOOK

Helps Figure Time Costs

$10

Save time and money! Quickly, you can estimate labor time involved for completion of a unit of work. Designed for mechanical contractors and mechanical engineers. A REAL TIME-SAVER! A 7-section book, dealing with Air-Conditioning, Heating Equipment, Plumbing, Fittings, Valves, Pipe, Pumps, Misc. (Inc. insulation, water meters, tanks, etc.) A popular, proven, national time-cost book! Spiral-bound 70-page book, pocket-size. Send for book and see how much time you save, estimating a job!

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KEEP INFORMED

BUSINESS NOTES · NEW EQUIPMENT · LATEST CATALOGS

Penton-Sheet Tank Linings

Extruded Penton sheet in 48-in. wide rolls, formerly available only in narrow widths, is announced for corrosion-resistant lining of tanks, vessels, and other equipment by National Vulcanized Fibre Co.

These extra-wide rolls cut application costs because more surface area can be covered with a single width. This reduces the number of seams and seaming material required, cuts welding time and expense, and speeds installation.

The use of these chlorinated polyether linings, which have a wide range of chemical resistance at elevated temperatures, is a practical means of incorporating corrosion and abrasion resistance in many kinds of equipment operating in moderate to severe corrosive environments.

Penton linings are applied both to existing equipment in the field and to new equipment during fabrication. Typical applications include linings for plating tanks, process vessels, fume hoods and ducts, large-diameter pipes, pickling tanks, vats, columns, and other process equipment. These linings are also used in motor and rail tankcars carrying corrosive fluids.

Equipment lined with Penton can be made of less-expensive materials, such as steel, saving on initial cost.

National also supplies 0.040 and 0.062-in. Penton sheet in narrow widths. Other thicknesses are available on request. The heavier-gage material is designed for conditions of severe abrasion. Also supplied are Penton welding rods, welding seamers, and corner strips for use in installing the Penton lining.

Additional information is available from the company. **—K–43**

Hand Valve

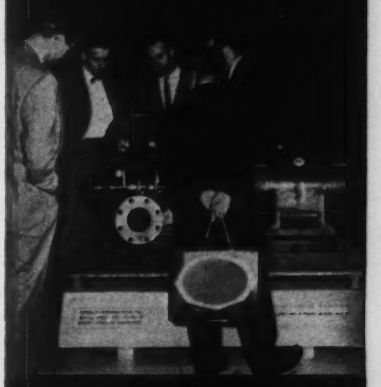
Positive shutoff and freedom from galling are the features of a new "floating-cone" 1/4-in. hand valve announced by Foxboro Co. Recommended for liquid or gas service on meter manifolds, seal chambers, hydraulic equipment, and similar applications, the new valve is supplied in five variations of globe and angle types, accomodating line pressures up to 3000 psi.

Instead of the conventional one-piece plug and stem, the stem of the new cone valve terminates in a socket which holds the knuckle of a conical shape plug. With the plug firmly seated at closure, the stem is free to rotate on the knuckle surface; no amount of further tightening will score the polished cone.

Stem is of Type 416 stainless steel; packing gland of Type 303 stainless; body, bonnet, and union nut of heavy-duty steel. Teflon ring packing keeps friction to a minimum, requires no lubrication. Bonnet is precision aligned with body for accurate seating of plug; bonnet seat checks rise of stem and provides seal to permit repacking at full line pressure. **—K–44**

WHAT'S BUILDING UP IN

PUMPS AND COMPRESSORS?



Often regarded as the "heart" of a system, pumps and compressors merit frequent re-evaluation to determine that you are using the right machine for a specific application.

Listening to the "heartbeat" of pumps and compressors can best be done at the Power Show, where you can ask questions, investigate and compare, get first hand answers from the manufacturers themselves. There you'll also see a broad line of other power and allied equipment.

At the Power Show you'll be in direct contact with manufacturers, enabling you to get specific, direct, authoritative answers to your questions. Only at the Show will you see more than 250 leading suppliers' products, all conveniently grouped together.

Make sure you're there. Everyone else will be!

2448

24th NATIONAL EXPOSITION OF POWER & MECHANICAL ENGINEERING

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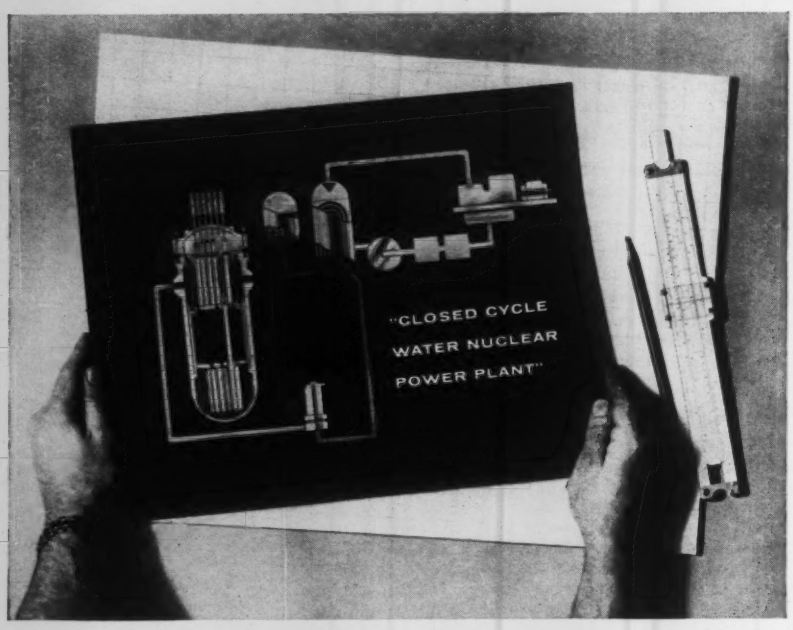
NEW YORK COLISEUM

NOV. 28—DEC. 2, 1960

MANAGEMENT: INTERNATIONAL EXPOSITION COMPANY
480 Lexington Ave., New York 17, N. Y.

NEW PROFESSIONAL GROWTH OPPORTUNITIES for PHYSICISTS, SCIENTISTS, ENGINEERS, (Metallurgical, Chem., Mech.)



330-1 REACTOR—With a reactor vessel and closure head weighing 418 tons, standing 41 feet high and having a 12 foot ID, the engineers and scientists at the Commercial Atomic Power Department visualize a power system that can produce 360 gross electrical MW. This is the scope of planning now in progress at APD. You can take part in this or other phases of the rapidly expanding commercial nuclear power field where your talent can be applied to the problems of making nuclear energy competitive with other forms of power.

Scientist-Engineer—To analyze transient conditions in nuclear reactor systems; development of equations describing the nuclear thermal and hydraulic conditions within system components. Should have several years experience with analog and/or digital computational techniques. B.S. or M.S. in Engineering, Physics or Mathematics.

Engineers—To plan, direct installation and shakedown operations of environmental loops for testing facilities. B.S. degree in engineering, with minimum of two years experience on in-pile loops or high pressure test facilities.

Scientists or Engineers—To plan, conduct and interpret radiochemical experiments associated with induced and transported radioactivity in nuclear plants and consult on problems of a radiochemical nature. B.S. degree in Chemistry or Chem. E. with minimum of three years related experience.

Engineer—For mechanical design of primary loop components such as: pressure vessels, piping, pumps, valves and heat exchangers for a nuclear plant; with particular emphasis on mechanical and thermo stress analysis. B.S. M.E. degree with experience in similar or related fields.

If you can visualize your professional growth in an atmosphere of scientific investigation, write to: Mr. C. S. Southard, Westinghouse Atomic Power Division, P.O. Box 355, Dept. X-31, Pittsburgh 30, Pa.

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BUSINESS NOTES · NEW EQUIPMENT · LATEST CATALOGS

Rotary Switch

The development of a rotary circuit selector or stepping switch powered by the new Size 5 Digimotor has been announced by Ledex Inc.

The Digimotor drive is a highly reliable, long-life power unit, available in unidirectional or bidirectional models. It is permanently lubricated, jam-proof, and operates at a "whisper" noise level. The drive has a magnetic anti-overcoast, and all parts are enclosed in a protective housing.

Self-stepping is provided by a new transistorized pulser incorporated into the switch package. With no mechanical parts to wear out, unaffected by dust, humidity, fungus, or variations in altitude the pulser meets all environmental requirements of MIL-E-5272. Standard stepping rate is 6 to 8 pulses per sec, but faster stepping can be provided.

The free-turning shaft allows manual setting of the switch to any position, clockwise or counterclockwise, and shaft extensions allow mounting of supplementary loads and position indicator.

The new switch can be ordered with one through ten switch decks, and in 8, 10, 12, 18, 20, and 24 positions. **—K-45**

Reducers

Foote Bros. Gear and Machine Corp. has begun marketing a new line of small-size worm-gear Radicon reducers, featuring center distances as low as $1^1/_8$ in. The name "Radicon" is derived from radiation and convection and is intended to emphasize these important heat-transfer features of the line. They are designed to complement the wide range of gear reducers now manufactured by Foote Bros., and to provide distributors with a broader product base under the firm's new expanded industrial-marketing program.

Fan-cooling promotes maximum thermal capacity. Detachable feet give unlimited mounting flexibility. The units are available in 12 sizes with center distances from $1^1/_8$ to 8 in., with input capacities from 0.01 to 68 hp, and with output torque up to 46,000 lb-in. Speed ratios are available from 5 : 1 to 70 : 1. **—K-46**

Pressure-Reducing Valve

Now available in 4 and 6-in. sizes from OPW-Jordan, an air-operated Sliding-Gate-and-Plate Pressure-Reducing Valve has capacity of 50,000 lb per hr of steam or 2500 gpm of water. Used to reduce pressure wherever large capacities, accurate control, and tight shut-off are required, the system is suitable for pressures to 250 psi and temperatures to 500 F. Main valve is available in ductile iron and cast iron, flanged. The valve features sliding gate and plate seats, lapped to lightband flatness. Seats are self cleaning and self-lapping to give tight shut-off and minimum maintenance. **—K-47**

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SPECIFY THOMAS
FLEXIBLE COUPLINGS

Like a THIEF in the NIGHT an inferior coupling causes wear and damage to your machines—resulting in high maintenance costs and costly shut-downs.

Troublesome maintenance problems and down time are eliminated when you specify Thomas "All-Metal" Flexible Couplings to protect your equipment and extend the life of your machines.

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COUPLING CO.
WARREN, PENNSYLVANIA, U.S.A.

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BUSINESS NOTES
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Calibration Unit

With the B575 tester, the Liquidometer Corp. has introduced a lightweight, portable unit for calibrating its fuel-quantity gaging systems on the Grumman Gulfstream aircraft.

This completely self-contained unit has built-in test values which are secured by turning the appropriate switch on the clearly marked control panel. Simplified operating procedure saves time ordinarily spent when using laboratory-type testers which require painstaking settings for exact values.

The compact B575 is easy to store and therefore available on the aircraft at all times. Weighing only 2 lb, its use for instant testing eliminates the need for more elaborate, cumbersome equipment. Complete test harnesses for interconnection with the system are secured within the cover of the aluminum carrying case.

The Liquidometer Corp. also supplies the fuel-quantity gaging systems, and test equipment for calibration, on the Douglas DC-8, the Republic F-105 Thunderchief, and the Boeing B-52 Stratofortress. —K–48

BUSINESS NOTES

New Divisions

The Permutit Co., Div. of Pfaudler Permutit Inc., has just formed two new divisions. A Chemical Division, consolidating all former Permutit chemical activities, will operate as the Ionac Chemical Corp. A new Industrial Division will continue to do business as The Permutit Co. The Industrial Division includes all Permutit operations except Ionac Chemical and the Simplex Valve & Meter Co.

Permutit is the oldest and largest producer of water-treatment equipment and ion-exchange resins for general industry, processing plants, power companies, municipal water systems, and home water conditioning. The reorganization was the result of an extensive market study which revealed great growth potential for these two branches.

The Chemical Division will be headquartered in Birmingham, N.J. All chemical sales and service activities, including Ionac Resins, will be transferred from the New York office and consolidated with the company's chemical-manufacturing plant, research center, and water-analysis laboratories already located there.

Permutit's new Industrial Division will continue to be headquartered in New York City where it has extensive engineering, sales, and administrative offices.

DON'T OVERLOOK
STEAM
SPECIALTIES

If you believe that it's often the little things that count, you will pay attention to such items as steam specialties. Often used in large volume, their performance can contribute substantially to profit or loss in your company's operations.

You will see at the Power Show such steam specialties as steam traps, strainers and separators, steam cleaners, controllers and regulators, temperature and pressure instruments, indicating and recording devices, as well as a complete range of power and allied equipment ready for your inspection.

Here is your opportunity to investigate, compare, and get the right answers, face-to-face, from the manufacturers themselves. Only at the Power Show can you see over 250 leading suppliers' products, all conveniently grouped together.

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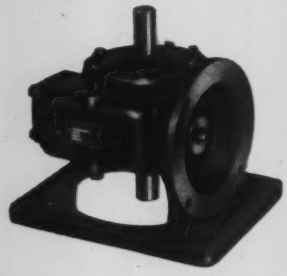
Yes! 956 different combinations of Perfection Motorized Worm Gear Speed Reducers are available for immediate delivery, *from stock.* Ratios range from 5 to 1 to 60 to 1, in capacities from 1/6 H.P. to 5 H.P. Perfection "C" Flange Reducers may be ordered complete with motor or without motor, to be used with a motor *of your own choice.*



Flanged motor reducers offer the maximum in compactness, rigidity and adaptability. Through the use of standard NEMA face mounted motors, complete interchangeability between motors is provided. Motor maintenance is possible without disturbing the drive and reducer. Motor assembly is fast and positive with no alignment problems.

Write for your free copy of our new 28 page catalog containing illustrations, charts and tables to help you choose the right Reducer for your particular application. Ask for Bulletin No. M-140.

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AMERICAN STOCK GEAR DIVISION
PERFECTION GEAR COMPANY, HARVEY, ILLINOIS

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BUSINESS NOTES
NEW EQUIPMENT
LATEST CATALOGS

Canadian Subsidiary

Arthur D. Little, Inc., announces the establishment of a subsidiary in Canada to be known as Arthur D. Little of Canada, Ltd., and located at 120 Eglinton Ave. East, Toronto 12, Ontario.

LATEST CATALOGS

Grating

Electronically welded steel grating and treads custom made to fit requirements is described in a 12-page folder issued by Kerrigan Iron Works Co. Tables of weights and safe loads and other engineering data are included as well as data on fasteners and special treads. **—K-49**

Pumps

Self-priming pumps, made by the Jabsco Pump Co., for liquid transfer and circulation with a single moving part are described in a four-page leaflet. The moving part is a tough, long-lived, wear-resistant neoprene impeller self-lubricated by water and other nonlubricating liquids. Standard models are available in $\frac{1}{4}$ through $1\frac{1}{2}$-in. sizes, with a speed range of 75 to 1750 rpm. Pressures range from 20 psi max for the smaller sizes and up to 45 psi for the larger. Suction lifts up to 15 ft unprimed and as high as 25 ft when primed are provided. **—K-50**

Crushers

American WC and WS series hammermills and shredders, rolling-ring crushers, and special-purpose crushers made by American Pulverizer Co. are described in a four-page bulletin. Standard models are made for reducing chemicals, minerals, ceramics, metals, and a variety of other uses. The company will also custom-design crushers to melt special needs. **—K-51**

Seamless Welding Fittings

A 12-page illustrated bulletin announcing the addition of seamless-type welding fittings to its established line of welded-type fittings has been published by Midwest Piping Co.

All types of Midwest standard fittings are shown, with their size ranges, and numerous examples of Midwest special fittings and their application are given. **—K-52**

KEEP INFORMED

BUSINESS NOTES
NEW EQUIPMENT
LATEST CATALOGS

Screw-Conveyer Drives

Bulletin 7106, issued by the Falk Corp., presents details on new screw conveyer drives, available for applications in range from 1/2 to 30 hp (output torque to 21,400 lb-in.), in four ratios, designed to bolt to standard trough ends.

Design features and accessories are described, including choice of trough-end seals; removable drive shafts; optional trough ends; and optional Falk motor mounts which permit mounting motors directly on the reducers, for maximum economy and convenience. Technical data includes selection and dimension information, NEMA motor dimensions, and nominal sheave ratios for typical unit ratios and conveyer speeds. —K-53

A-C Motors

A-C multi-shielded motors are listed in a 56-page catalog, issued by Sterling Electric Motors, Inc. Complete pricing, dimensional, selection, and application data are given on motors ranging from 1/4 to 200 hp. Information is included for various modifications, such as specialized mountings and enclosures, as well as the new Sterlicone Multi-Shielded drip-proof motors. —K-54

Thermocouples

The Bristol Co. has released Bulletin P1281A describing Bristol's Armorox thermocouples. The metal-sheathed, ceramic-insulated construction of the thermocouples is explained, and typical applications are cited. Complete specifications of various Armorox thermocouples are given. —K-55

Hard-Carbide Compositions

More than 75 "Proven Uses of Kennametal and Kentanium" are illustrated in a 24-page booklet, No. B-666, published by Kennametal Inc. The several exceptionally enduring properties of these hard-carbide compositions are stressed. Records show wear resistance up to 100 times that of steel, high resistance to impact, deformation, corrosion, and oxidation at temperatures of 2200 F and above.

Cost-saving applications in more than 25 industries are described. —K-56

Fluid Power

Issue No. 13 of the *Oilgear Fluid Power News*, available from the Oilgear Co., describes and illustrates the solution of varied engineering problems through the application of fluid-power equipment. Electrohydraulic power and control systems for a seagoing hopper dredge; precision speed synchronization and control of new extensible paper machine section drives; drive synchronization for a seven-stage food-packaging line; and the use of fluid power to handle the rudder on the new Great Lakes ship *S. S. Edmund Fitzgerald*, are covered in this issue. —K-57

Don't take chances on couplings

COUPLING A BILLION HORSEPOWER

CHECK PUBLISHED MISALIGNMENT RATINGS BEFORE YOU BUY

Since misalignment is the basic problem that shaft couplings are designed to solve you'll find a published conservative misalignment rating (along with load capacity rating) for every Fast's Coupling. Compare it with the misalignment rating of any other coupling you are considering.
One further advantage of Fast's Couplings' misalignment ratings: You save money on installation because, knowing the ratings, you don't have to line up driving and driven elements with pinpoint accuracy. It's one more important reason why Fast's Couplings are the choice of more equipment manufacturers than any other gear-type coupling.
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Less weight . . . modern contour . . . amazing adaptability for special mounts plus LOWER COST than conventional blind flanges. These are a few of the advantages of Lenape ASA DISHED COVERS that compel attention.

Full information and specifications are given on pages 48-49 of the Lenape General Catalog. Write for your copy today.

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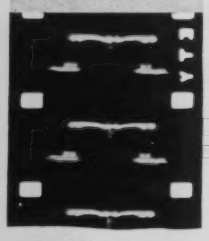
NEW EQUIPMENT BUSINESS NOTES LATEST CATALOGS

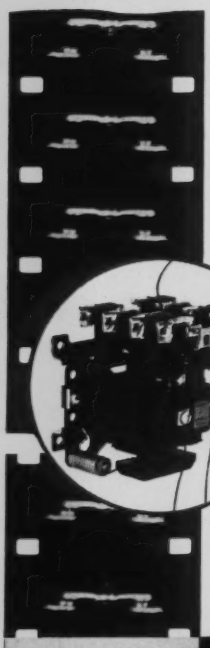
Pipe Connections

The first complete catalog of pipe connections and accessories designed on the new Grayloc seal principle, which eliminates connection leakage at pressures to 40,000 psi, and permits design for high resistance to thermal shock and vibration, has been published by Gray Tool Co.

The 44-page manual contains all new types and ratings of Grayloc clamps, collar-type unions, flanges, vessel nozzles, closures, and bleeder valves, as well as products with related applications. An exclusive 10-page table gives allowable working pressures for pipe and connections from 1 to 30 in. inclusive to 1500 F. —K-58

Actual reproductions from FASTAX high-speed films, taken at 7,500 frames per second, used to analyze contact operation.





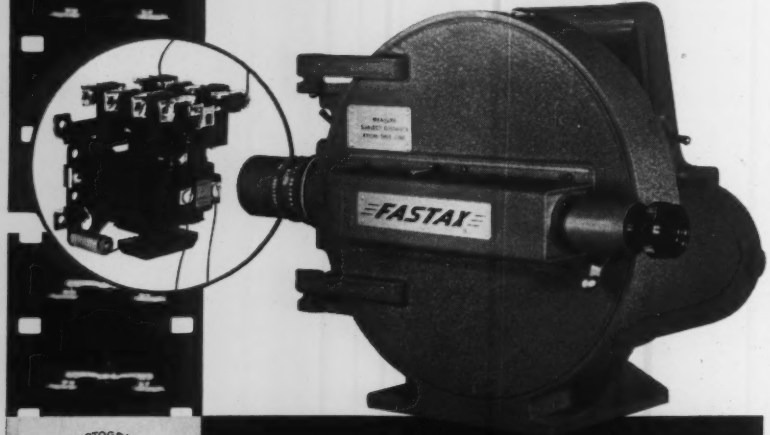
How Allen-Bradley uses *FASTAX* to check super-speed components

Allen-Bradley engineers had to *know* how contacts in their motor control relays stood up under stress, when operating too fast for the human eye to follow.

Using a FASTAX high speed motion picture camera, they *photographed* contact action and got a permanent, accurate record at a film speed of 7500 frames per second.

Later, when projected at slow speeds, Allen-Bradley engineers could examine the structural behavior of relay components—contacts, plungers and springs. Motion studies like this have helped develop better relays for A-B customers.

For all around research and industrial use, the FASTAX is the most versatile motion analysis tool available. With framing rates up to 18,000 pps and effective shutter speeds up to 1/800,000 of a second high speed subjects of every variety can be observed in slow motion.



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WRITE for new descriptive literature.

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Numerically Controlled Machine Tools

A new 12-page booklet containing some general information on numerically controlled machine tools and describing three specific types of machines in use today has been published by Ex-Cell-O Corp. These were designed and built specifically for numerically controlled operation, and all use continuous-path control.

One mills complex, drum-type fuel-control cams for aircraft engines. The second performs milling and grinding operations on irregularly shaped parts, such as jet-aircraft engine blades, steam-turbine buckets and drum-type cams. With a simple work-holding fixture it also grinds flat templets. The third machine performs precision boring, turning, and contouring operations using a single-point tool, and also is equipped with an alternate grinding head and suitable fixtures for grinding flat templets and circular cams to extremely close tolerances. —K-59

Packing Chart

A packing recommendation chart, prepared by the Packing Div., Raybestos-Manhattan, Inc., shows maintenance and engineering personnel the proper packing types to choose for specific applications. Suitable for posting on the wall, it suggests seven basic packing types for 95 per cent of all packing needs, including such applications as: Pumps and valves, high-temperature valve stem and expansion joints, high-speed rotary air compressors, corrosive and viscous liquids, chemicals, gasket applications, and hydraulic and pneumatic equipment. —K-60

Flaw Detector

Ultrasonic flaw detection is the subject of a new bulletin, T200, issued by Branson Instruments, Inc. The eight-page booklet includes operation, techniques, and a complete list of specifications for the Sonoray 5 flaw detector.

Advantages of a new pulse-echo instrument, which has exceptional low-frequency resolving power and penetration are described. Compact and portable, it is claimed to be the smallest and lightest high-performance instrument on the market. It is inexpensive, easy to operate, and involves no radiation hazard. —K-61

Seals

Mechanical shaft seals for all types of products and operating conditions, custom-designed and manufactured by Cartriseal Corp., are described in a 32-page catalog. Cartriseal's basic O-ring, cartridge, grommet, labyrinth, bellows, and boot-type designs can be modified to meet any requirement. The company also selects materials and tailors mating rotors to fit customer needs. —K-62

KEEP INFORMED

NEW EQUIPMENT BUSINESS NOTES LATEST CATALOGS

Fittings and Flanges

Expanded size range for its exclusive taper-face flanges is described in revised Bulletin TT 942, "Fittings and Flanges for Light Weight Piping," available from Tube Turns Div. of Chemetron Corp. Dimensions are given for the complete line of lightweight welding fittings available in ¾ to 24-in. nominal pipe sizes and for its exclusive 125-lb forged-steel lightweight taper-face welding neck flanges. —K–63

Press Brakes

A revised catalog on Steelweld mechanical press brakes has just been completed. The 50-page book covers latest features and new models added to the Steelweld press line. The table on specifications has been greatly enlarged and covers machines from 160 to 1250 tons, mid-stroke capacity.

Ask for Catalog No. 2023-B. from the Steelweld Machinery Div., the Cleveland Crane & Engineering Co. —K–64

Dust Separators

Day Dual-Clone dust separators are detailed in Bulletin D-20 released by the Day Co. The eight-page bulletin includes performance data, installation photos, selection, and dimension charts for Dual-Clones and Dual-Clone supports.

The basic principles of dust separation by cyclonic action are utilized plus patented Day-designed internal "skimmers" which produce a two-stage separation within the Dual-Clone collector. Day Dual-Clones have no moving parts and can be furnished in 22 standard sizes to handle air volumes from 250 to 23,750 cfm of air. Multiple groupings handle several systems of dust collection and higher air volumes. —K–65

Transformer

Features which contribute to speedy installation of Allis-Chalmers Mfg. Co. small, light, dry-type transformers described as whisper-quiet are detailed in a new bulletin released by the company. They are made in ratings 3 through 50 kva, single-phase, 600 volts and below, for on-the-site load-center applications where critical voltage must be maintained and provide 80-C rise, ventilated, indoor dry-type operation with low-loss, low-exciting-current. —K–66

Force Gages

The complete line of Hunter Mechanical Force Gages is described in detail in Bulletin 750/FG, published by the Hunter Spring Co., Div. of American Machine and Metals, Inc. Each of the company's 21 precision, direct-reading gages is included in the four-page bulletin. These can be used for measuring both tension and compression loads in ranges of from 0 to 500 grams up to a maximum of 0 to 500 lb. —K–67

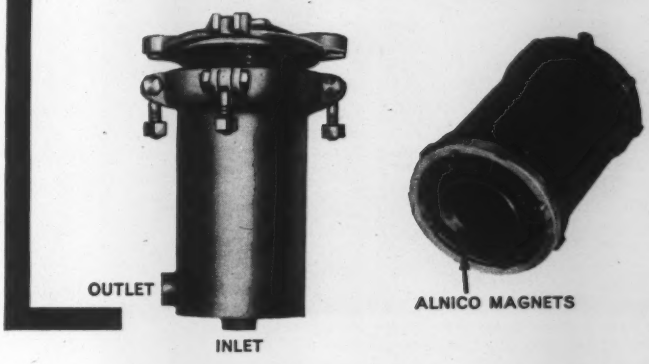
Pyrometers

A six-page data sheet describes the Leeds & Northrup Co. line of pyrometers for temperature measurements up to 7600 F or 4200 C in plant or laboratory.

Construction and operation of the potentiometer-type L&N optical pyrometer are described with the application of the "disappearing-filament" method of temperature measurement illustrated. Accessories include a lens for sighting on glowing objects as small as 0.003 in., and emissivity screens for molten-metal applications. Equipment for comparison checking of pyrometers is also listed.

Write to the company for a copy of Data Sheet ND42-35(1). —K–68

GET THE *ADDED PROTECTION* OF MAGNETIC SEPARATION WITH THIS BASKET-TYPE STRAINER



Nugent now manufactures a line of basket-type strainers offering the added protection of magnetic separation. Specially designed Alnico magnets establish a magnetic field through which the strained liquid must pass as a final stage before leaving the unit. Thus, minute ferrous particles are trapped and removed from the fluid stream.

If you have valuable engines or other equipment which demands top-notch lubrication protection, it will pay you to get the full story on the Nugent combination strainer-magnetic separator.

Write today . . . no obligation, of course.

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WM. W. NUGENT & CO., INC.
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SIGHT FEED VALVES • FLOW INDICATORS

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NEW EQUIPMENT BUSINESS NOTES LATEST CATALOGS

Felt

Some of the varied uses of the 800 types of specifically-designed "A-Plus" felts manufactured for industrial and decorative uses by the American Felt Co. are described in an eight-page booklet.

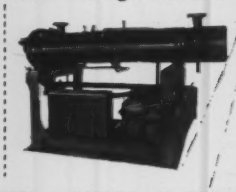
Standard, laminated, coated, and impregnated felts are included. Classifications by use are spacing, surfacing, and padding; vibration isolation; sound absorption; percussion control; thermal insulation; felt as a seal; as a polishing agent; for cushioning and packaging; as a friction agent; a shock absorbent, and as a wicking agent. Technical Data Sheets and other available publications are listed. **—K-69**

Huge 180 foot Federal Barge Lines towboat, the United States, has 50% greater horsepower than the largest towboat on the rivers. It can push 40 barges, totaling 1/3 mile, or 300 ft. longer than the "Queen Elizabeth".

C-103

Space saving design versatility? Easy installation? Operating dependability? Comparative cost? All these factors were considered by St. Louis Shipbuilding and Steel Company in the selection of air conditioning equipment for the world's most powerful towboat. The shipbuilders' and their design engineers' careful choice? A Curtis 20-ton packaged liquid chiller system. This equipment will cool the crew's quarters, galley, mess room, officers' and guest quarters—all with individual room or area temperature control.

The Curtis complete line, and reputation for dependability in installation of all types, work to the benefit of engineers and mechanical contractors. Factory run-in of all units cuts call backs far below average. You can safely promise dependable performance always up to, and frequently surpassing, rated capacity. You eliminate your problems when you specify Curtis, because you're working with an outstanding manufacturer of air conditioning equipment.



THE COMPLETE LINE OF LIQUID CHILLERS • PACKAGED AIR CONDITIONERS • CONDENSING UNITS

Curtis *ESTABLISHED IN 1854*

MANUFACTURING COMPANY • REFRIGERATION DIVISION • *St. Louis 33, Missouri*

Tubing Selection Guide

The selection of steel tubing according to type, finish, analysis, formability, machinability, weldability, and relative cost is made easy through comparative listing of characteristics in a new guide published by Joseph T. Ryerson & Son, Inc.

These are given for seamless and welded round, square, and rectangular tubing for mechanical, hydraulic-cylinder, fluid-line, and structural applications. Elements such as size range, wall thicknesses, and stock lengths, along with the ability of the tubing to develop added strength and hardness through heat treatment, are also included. Tips on when to use tubing instead of bar stock round out the data. Request technical Bulletin No. 12-10. **—K-70**

Machinery Mounts

Data on stopping vibration, shock, and noise transmission by using steel-spring machinery mountings has been published by the Korfund Co.

The superiority of steel springs in controlling vibration and shock is explained, and the Korfund Series L Vibro-Isolator, a standard, catalog unit is described. A series of eight typical case histories is given and the many variations available in Korfund mountings to meet a variety of difficult operating conditions are detailed. Request Bulletin K3C. **—K-71**

Pyrometer

Temperature measurement up to 4000 F using a radiation pyrometer in an a-c bridge circuit is illustrated in new four-page Product Specification E51-4, issued by Bailey Meter Co. The principle of operation is described and a curve shows high millivolt output versus temperature. **—K-72**

Turbine Supervisory Instruments

A General Electric bulletin describes supervisory instrumentation for industrial turbines. Called "New Turbine Supervisory Instruments (TSI)," Bulletin GEZ-3078, has 12 pages, and includes description and specifications of the G-E compact redesign of a TSI system that charts a permanent record of mechanical performance throughout starting and running periods. Detailed description of the new system's ability to monitor vibration, shaft eccentricity, shell and differential expansion, speed, and valve position, is included.

Another four-page bulletin, "Exchange Plan for Turbine Supervisory Instruments," GEZ-3077, details credits allowed by GE for earlier TSI models when replaced by the new system. **—K-73**

KEEP INFORMED

NEW EQUIPMENT
BUSINESS NOTES
LATEST CATALOGS

"Stock Cylinders"

Top quality, immediate shipment, and substantial price savings are the keynote of a new bulletin on Miller "stock" air and hydraulic power cylinders.

The center spread of the four-page bulletin gives the strokes, prices, and dimensional data on the expanded "stock" selection which now embraces Miller air cylinders in $1^1/_2$ through 14-in. bores; Miller Model J job-rated hydraulic cylinders for 500 to 2500-psi service in $1^1/_2$ through 14-in. bores; and Miller Model H power-packed hydraulic cylinders in $1^1/_2$ through 8-in. bores for 3000 to 5000-psi service.

Write Miller Fluid Power Div. of Flick-Reedy Corp. **—K-74**

Miniature Bearings

Northfield Precision Instrument Corp., offers new Design Catalog 60-01, an illustrated description and guide for the selection of Microspin miniature precision sintered-bronze instrument bearings.

They are designed for a wide variety of applications which do not justify the cost of ball bearings, but where precision instrument standards of tolerances, life, and low friction must be maintained. **—K-75**

Variable-Speed Motors

A controlled-acceleration accessory unit for 1 to 75-hp Varidrive variable-speed motors has been developed by U. S. Electrical Motors Inc. Request Bulletin F-1797 and Specification Sheet Section 300, Page 64.4.

The control provides a soft, smooth start to minimize any sudden starts that could damage the machine being driven or the product, such as paper, plastic, or textile materials. The control would also protect equipment such as extruders where high starting torque may be detrimental to the extruding machine or the Varidrive.

To accomplish low initial torque, a reduced-torque control unit is used. To suit varying load conditions and machine applications, starting torque is infinitely adjustable up to the normal rated torque of the motor. After setting the control unit for the desired starting torque, a compensator unit maintains this same approximate torque from starting to full operating speed. When operating speed is attained, the control unit is automatically removed from the circuit and the Varidrive operates normally.

The controlled-acceleration unit is designed to operate on standard 220/440-volt, 60-cps power supply, and is constructed of long-life nonelectronic components, insuring maintenance-free operation. **—K-76**

Fans

The Series 116 centrifugal-type airfoil-bladed fans available from American-Standard Industrial Div. are described in a new 60-page bulletin, No. A-1103. The bulletin discusses features of the new fans and lists suggested applications. Another section on methods of volume control compares outlet dampers, variable inlet vanes, slip ring motor and Gyrol fluid drive in terms of effectiveness, power requirements and cost.

Thirty pages of capacity tables for standard air conditions are given, covering the full line of 15 sizes in both single-inlet and double-inlet construction. **—K-77**

PRECISION
BORED and HONED PARTS
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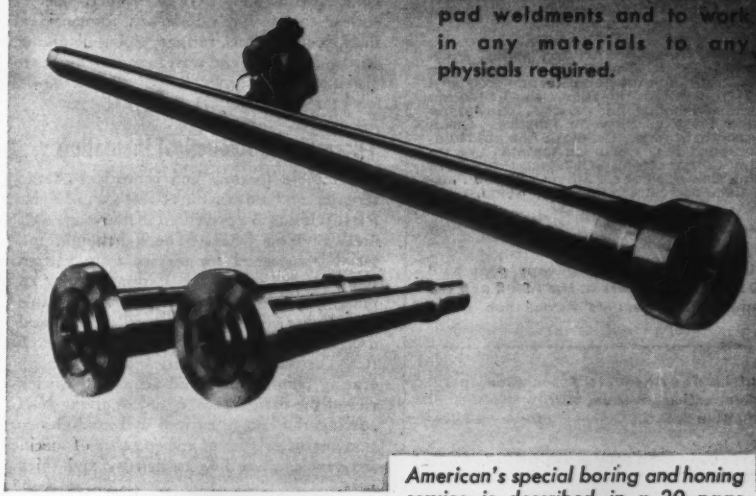

American's special boring and honing service is described in a 20 page brochure. Write for a copy.

AMERICAN HOLLOW BORING CO.

You can depend on American as a reliable source for precision bored and honed parts for your most exacting applications.

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You will know more about the properties of commercially available plastics and the variables that affect them after you have read

TECHNICAL DATA ON PLASTICS

Here, in 224 pages, are graphical and tabular data on fabrication, durability, electrical, mechanical and miscellaneous properties of twenty-five types of plastic materials along with a description of each type, a discussion of the chief characteristics of its properties, and a list of its applications. Pointers for designing plastics for strength are given, and a bibliography of additional sources of information included.

The data presented were derived from tests made by fifty leading manufacturers, the test methods used being those established by the American Society for Testing Materials wherever an applicable ASTM method exists.

All data and general information are presented in a form not available in any other publication.

PLASTIC MATERIALS
for which data are given include:

Thermosetting Materials — Urea-Formaldehyde Molding Materials. Melamine-Formaldehyde Molding Materials. Phenolic Molding Materials. Alkyd Molding Materials. Silicone Molding Materials. Epoxy Resins. Cast Phenolic Resins. Laminated Thermosetting Products. Allyl and Polyester Plastics.

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Published, 1957. $3.25 per copy post paid ($2.60 each to members of the ASME and the Manufacturing Chemists' Association, Inc.).

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Drawing Instruments

A catalog of drawing instruments issued by V. & E. Manufacturing Co. contains information on stainless-steel and nickel-plated steel $6^1/_2$-in. compasses, $6^1/_2$-in. speed bow compasses, $4^1/_2$ and 4-in. compasses and pen compasses; pen attachments; beam compasses and beam attachments; friction dividers; drop bow compasses; and a broad range of ruling pens. **—K–78**

Back-Up Rings

An eight-page design and data catalog, No. 5482, on Parbak back-up rings, published by Parker Seal Co., gives information on sizes and dimensions, and compound information.

The catalog shows how to increase O-Ring life, seal higher pressures and reduce costs with the use of the only contoured and continuous back-up ring, Parbak. **—K–79**

Air Conditioners

A 12-page manual includes product details and technical data on the Dunham-Bush, Inc., packaged air conditioner line.

Quick visual analysis is provided of the fan section, panels, filters, cooling coils, drain pan, electrical controls, condensers, (water and air-cooled), refrigerant drier-strainer, liquid sight glass, receivers, refrigerant charge, compressors and cabinet. Accessories, capacity specifications, dimensional data, specifications, ratings, piping diagrams, wiring diagrams, and warranty statement are also included. **—K–80**

Thermal and Acoustical Insulation

Complete thermal and acoustical characteristics of Baldwin-Ehret-Hill's Fine-Fyber felt insulation are presented in four-page technical Bulletin J-661. The lightweight material is designed for service from subzero temperatures to 450 F. Various factory applied facings and coatings are available. Fine-Fyber felt is manufactured in six standard densities ranging from $^1/_2$ to 3 lb per cu ft. Thermal conductivities at various operating temperatures and acoustical efficiencies of the material are detailed, giving NRC specification range as well as sound-absorption characteristics at a wide range of specific frequencies according to density and thickness. **—K–81**

Ball Bushings

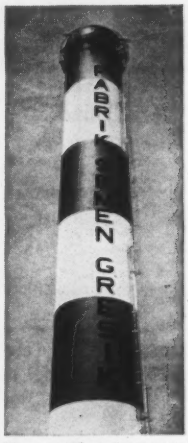
Newly developed Ball Bushings which are interchangeable with sleeve-type bushings in existing dies without modification of the punch holder are described in a two-page bulletin. They may be provided by the manufacturer or may be installed easily and simply by the die-set user. Available from Thomson Industries, Inc. **—K–82**

World-Wide Chimney Service

New Chimney design and erection
Radial Brick
Reinforced Concrete

Old Chimney repair and restoration

High Temperature and Acid Proof Linings



New, reinforced concrete chimney 175 ft. x 14 ft. 6 in. for cement plant of Pabrik Semen Gresik Company, Indonesia.

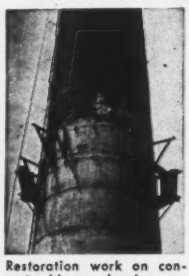
Designed by experienced chimney engineers to provide the correct height, diameter and type for highest boiler efficiency with lowest possible fuel cost. Designs, specifications, plans and recommendations furnished to meet your individual requirements.

Perforated radial brick of refractory clay molded to conform to chimney radius; joints broken vertically and horizontally.

Reinforced concrete employing adjustable steel forms both inside and outside to provide exceptionally sturdy construction, speedy and economical erection.

WE ARE CHIMNEY SPECIALISTS

with more than a quarter-century of successful design and construction for major utilities, institutions, processing and manufacturing plants in the United States, Canada, Mexico, and many foreign countries. Additional chimneys have also been designed and erected for these organizations as their power requirements have increased.



Restoration work on concrete chimney showing new material being bonded before waterproofing.

OUR SERVICES INCLUDE:

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Linings for Steel Stacks
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Whatever your chimney problem may be, Consolidated has the experience, knowledge and trained personnel to correct it.

Phone, wire or write today for information. Ask for catalog illustrating representative installations, listing engineering service and giving chimney design data.

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Ball Valves

New top-entry, top-adjusting thermoplastic ball valves made of unplasticized polyvinyl chloride or Penton chlorinated polyether are described in Bulletin TTP-180, "Ball Valves for Corrosive Service," issued by Tube Turns Plastics, Inc. The bulletin describes the new line's corrosion-resistance characteristics and on-the-line maintenance features and gives dimensions for threaded, socket, and flanged-end type valves in $\frac{1}{2}$ through 2 in. nominal pipe sizes. —K–83

Feeders and Rotary Valves

The complete line of roll and vane-type feeders and rotary valves being offered by Fuller Co. is described in new Bulletin F-5A. The feeders, built of cast iron or iron and steel combinations, are designed to handle a large variety of dry pulverized and granular materials such as chemicals, powdered metals, grains and food products, cement, clay, and mineral products, coal, biologicals, rubber, bone, and wood products. —K–84

Gears and Speed Reducers

A 246-page gear and speed-reducer catalog has been published by the Ohio Gear Co. Sizes, ratings, and specifications are given in addition to easy-to-understand engineering data on the proper selection of gears and reducers to meet specific job requirements.

Products covered include $14\frac{1}{2}$ and 20-deg pressure angle spur gears, bevel gears, mitre gears, worm and worm gears, spiral bevel gears, racks, and sprockets. An entire section is devoted to the new Hi-Line series of fin-and-fan-cooled speed reducers. More than a hundred other varieties ranging in capacity from small fractional to 25 hp are also covered.

Write to the company on company letterhead, and specify title or job classification. —K–85

Torque-Locking and Positioning Device

A unique dual torque-locking and positioning device is described in a bulletin available from Formsprag Co. The device will drive, position, over-run, and backstop in clockwise and counter-clockwise directions and in addition automatically and positively prevent torque feedback from either direction.

Opposing sets of sprags stop torque feedback from either direction but permit free rotation and transmission of high driving torque in either direction from the input to the output shaft. The device can also be used as a two-directional overrunning clutch, and driving torque can be transmitted at two speeds or reversed by connecting a low-speed reversible motor to the outer race and a high-speed motor to the input shaft member. —K–86

New fuel cut-out control by Reliance

Pipe one device for double protection

and add alarm for approaching low water level if desired...

Reliance Levalarm EA-100P

Using but one water chamber — one set of pipes to boiler — this new Reliance Fuel Cut-out and Alarm control gives you two efficient devices in one.

At one end (right hand above) a positive float-operated switch cut-out; at the opposite end, an electrode-type control using U.L.-approved transformer-relay hook-up — completely independent of the float-type control but employs a common water chamber.

Check these possible use-combinations of the Levalarm EA-100P:

1. Dual fuel cut-out control.
2. Float-operated fuel cut-out and electrode-operated low water level alarm.
3. Electrode-operated fuel cut-out and float-operated low water alarm.
4. Float-operated fuel cut-out and electrode-operated fuel cut-out and electrode-operated low water alarm.

This Levalarm is the convenient answer in cases where two independent fuel cut-outs are required.

And this Levalarm provides outstanding additional safety to the operation of factory assembled boilers.

Write today for full description of this new safety device.

The Reliance Gauge Column Company • 5902 Carnegie Avenue • Cleveland 3, Ohio

Reliance BOILER SAFETY DEVICES

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NEW EQUIPMENT
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LATEST CATALOGS

Line Strainers

Detailed information and specifications on the complete line of pipe line strainers made by the Air-Maze Corp. are given in a two-page data sheet.

Engineered to fit readily into lube oil, hydraulic, or air pipe lines these filters are designed to remove such contaminants as pipe scale, core sand, metal chips, or construction dirt that may exist after initial installation of equipment. —K–87

Rotary Table Feeders

An eight-page bulletin, No. 6093, describing standard Rex rotary table feeders has been issued by the conveyer division, Chain Belt Co.

Rex rotary feeders are designed for controlled feeding of sand, crushed ore, wood chips, and similar bulk materials providing an efficient method of metering material from vertical storage bins. They also allow constant, accurate control of the quantity of material fed onto conveyers and processing equipment, thus eliminating starving and flooding. —K–88

Ceramic-Spray Mountings

A new bulletin entitled "Mounting Sensing Elements" describes methods of mounting temperature and strain-measuring elements by means of Rokide ceramic spray coatings made by the Norton Co. This technique is being used to mount such elements in areas subject to high temperatures, such as rocket nozzles, gas turbines, nose cones. —K–89

Timing-Drive Selection

T. B. Wood's Sons Co. eight-page Bulletin 211 03, "5 Simple Steps to the Selection of Timing Belt Drives," gives a method involving a minimum of mathematics for the selection of a drive to fit any application. Curves for drive-width selection, developed by Wood's engineering department eliminate tedious computation. A standard timing belt catalog is the only outside reference needed.

The method of computation is illustrated by a sample problem; namely to connect a 15-hp, 1750 rpm, squirrel-cage motor, of NEMA design B and normal torque, to a turret lathe to operate at 875 rpm. —K–90

Torque Control

An automatic torque control unit for tube rolling, unique in that it operates off standard reversible electric drills or tappers (110 to 120-volt, a-c 60-cps), is described in a bulletin issued by the Gustav Wiedeke Co. Additional electric-power tools may be unnecessary with the unit since available electric tube-rolling motors may be utilized.

One instrument effectively controls the amount of expansion on tubes 1/4 through 4 in. OD, thus eliminating the large investment in two or three control instruments. —K–91

Strapping Tools

Tailoring the strapping tool to the packaging job is made easier with a new folder, "Signode Combination Strapping Tools."

A Signode combination tool performs four functions: Tensions strap, applies seal, makes joint, and cuts strap. Detailed descriptions and a chart of specifications and applications help to select the one Signode combination tool most efficient for the job in mind. Write Signode Steel Strapping Co. —K–92

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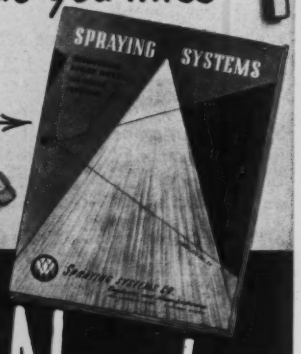

Spray Nozzles

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The most comprehensive spray nozzle catalog ever printed. Thousands of designs and sizes . . . unequalled choice of capacities, characteristics and materials. The result of over twenty-five years of specialized research, design and manufacturing.

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describes most efficient gas-to-gas heat exchanger of its size ever developed

Roto-Pak®, Air Preheater's newest gas-to-gas heat exchanger, packs more performance in less space than any heat exchanger you've ever seen. For example:

Size range: average 1′ depth x 20″ to 55″ diameter

Efficiency: recovers up to 90% of available Btu's

Capacity: handles up to 30,000 lbs/hr

Temperature range: up to 1000°F

Weight: less than 200 lbs for most models

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60 East 42nd Street, New York 17, N. Y.

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NEW EQUIPMENT BUSINESS NOTES LATEST CATALOGS

Thrust Bearing

A new catalog of cylindrical roller precision thrust bearings is announced by the Rollway Bearing Co. Detailed information on dynamic and static-bearing capacities, the company's patented tandem thrust bearings, new sizes of crane-hook bearings, and bearing applications are contained in the 28-page publication. —K–93

Adjustable-Speed Drives

Cleveland Machine Controls, Inc., has issued two bulletins which describe Sizes 1 and 2 of the company's Series-35 line of electrical adjustable-speed drives. Specifications, design and construction details, operational, installation, and application information are given.

A unique feature of these drives is their modular design, permitting greater flexibility of application without resorting to "specials."

Bulletin SL-351-460 describes Size 1 for electrical drives up to 1/4-hp max. Bulletin SL-352-560 describes Size 2 for electrical drives up to 3/4-hp max. —K–94

Chains and Sprockets

Selecting a chain from horsepower tables and how to specify sprocket wheels are just two examples of the information contained in the 168 pages of the new "Chains and Sprockets," Catalog No. 999, recently issued by Jeffrey Mfg., Co. It describes 14 of the most popular types of chains used in industry. Hub classes, sprockets, attachments, and drive-chain data are also covered. —K–95

Process Equipment

Descriptions and specifications on the complete line of laboratory and production blenders, vacuum tumble dryers, packaged pilot plants, process heat exchangers, a new Solids-Processors, and a general-purpose solids-flow valve manufactured by the Patterson-Kelley Co., Chemical & Process Equipment Div. are included in a new 20-page Bulletin No. 16-P

For a copy of the Solids Processing and Heat Transfer Equipment Bulletin, No. 16-P, write to the Patterson-Kelley Co., Inc., Chemical & Process Equipment Div. —K–96

Pressure Transducer

Details of a new Type 4-382 pot pressure transducer are given in a two-page illustrated bulletin issued by Consolidated Electrodynamics Corp., a subsidiary of Bell & Howell Co. The small, light-weight instrument is designed for missile and operational aircraft applications in low pressure ranges. —K–97

Pumping and Hydraulic Data

Cost of electrical pumping, how to survey a deep well, methods for testing pumps—these are but a few of the helpful facts contained in a newly issued 20-page manual titled "Useful Pumping and Hydraulic Engineering Data," issued by Peerless Pump—Hydrodynamics Div., Food Machinery and Chemical Corp., and designated Bulletin EM-77.

Written with strong emphasis on practical data for the engineer's everyday use, this manual has many useful charts and problem-solving formulas. For example, there are facts on how to figure NPSH, pump efficiency, mechanical and electrical equivalents, and a pipe-friction-loss Chart. —K–98

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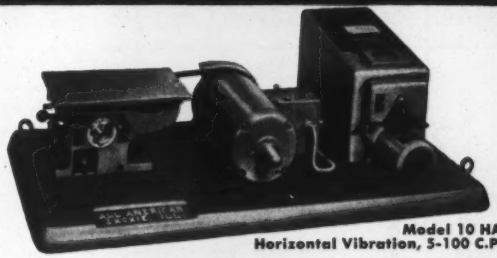
SPOT VIBRATION WEAK SPOTS BEFORE COSTLY FAILURE!



Model 10 HA-T
Horizontal Vibration, 5-100 C.P.S.

• How much vibration will your product take? Where are the danger areas? All American Vibration Fatigue Testers answer these questions in your shop or laboratory with shake-down tests that simulate field service vibrations. Engineering gets the facts needed to improve design at lowest cost. Equally effective in spot-checking production runs.

• All American Testers meet U.S. Government specifications for horizontal or vertical vibration testing of all sizes and shapes of units weighing up to 150 lbs. Range Selector automatically controls acceleration and deceleration, or holds vibration frequency at any desired point between 5 and 100 cycles per second.

CATALOG "F"
gives full facts on all 10 All American Testers, proved in long service to government and industry.
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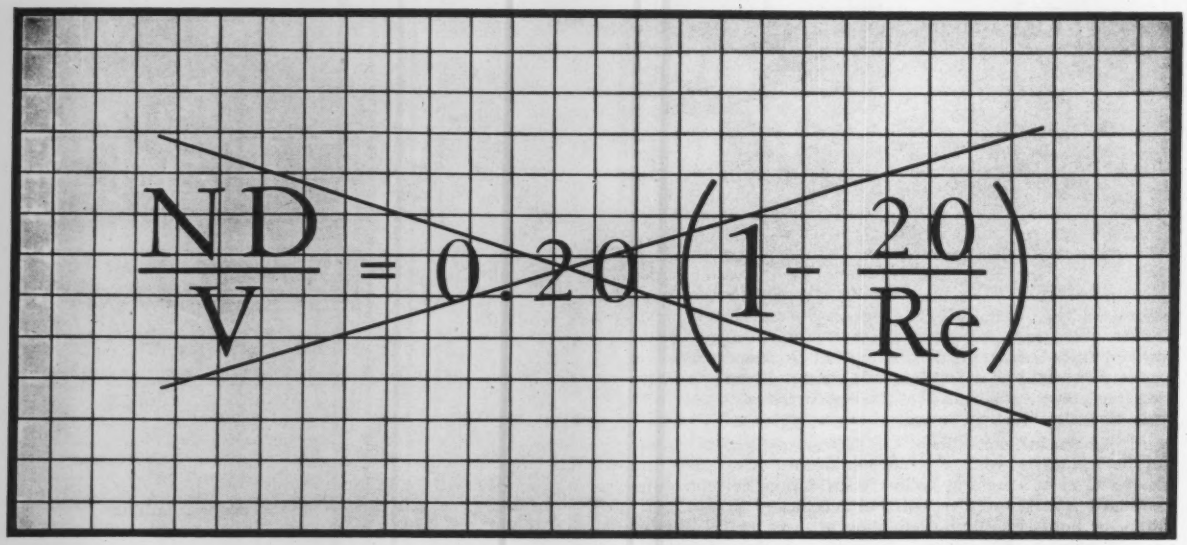
Since Von Karmen vortices or venturi effects are often absent in complex reactor flow and basic definition of the vibration phenomena cannot be described analytically, engineers at the Bettis Atomic Power Laboratory simulate reactor conditions of flow, pressure and temperature that experimentally describe reactor components sensitive to vibration.

Engineers—*With the ability to solve out-of-the-ordinary stress problems using basic concepts of the theory of elasticity, theory of plasticity and vibration analysis. The work is associated with the design and development of nuclear reactor cores. M.S. or Ph.D. desirable. If you are a U.S. citizen, write to: Mr. H. D. Altmire, Bettis Atomic Power Laboratory, P.O. Box 1468, Dept. B-73, Pittsburgh 30, Pa.*



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Westinghouse

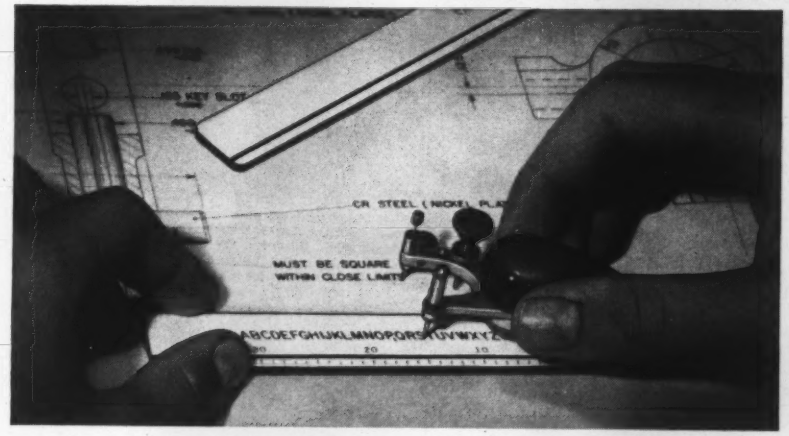
Some Ideas

for your file of practical information on drafting and reproduction ... from

KEUFFEL & ESSER CO.

When it comes to lettering – plain or fancy – professionals the world over turn to LEROY® Equipment by K&E. In drafting rooms, art departments – not to mention schools, business offices, churches, clubs, hospitals – LEROY has become almost as necessary as pencil and paper.

Truly, there's no magic about LEROY – just a beautifully simple idea, translated into products which reflect the highest manufacturing skill and imagination. Not easy, we grant you ... but not magic.



However, to keep the LEROY line constantly up to the changing requirements of the times – that *does* require a wizard. Fortunately, we have just such a gentleman firmly settled on the K&E payroll. And he begs that we report several of the more recent minor miracles of LEROY right here and now. So, in the famed standard, sans-serif lettering template, let's make with a little ...

abracadabra

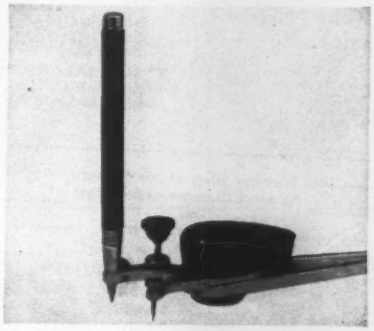
Templates

Every year sees new additions made to the already long list of LEROY templates. Case in point: the new electronic tube symbol templates for use in one of the most modern, fastest changing industries of them all. Also, there are foreign language templates (such as Russian and Greek), music templates, special designs, and a variety of handsome type faces (Caslon, Cartographic, Bernhardt Modern to name some newer additions).

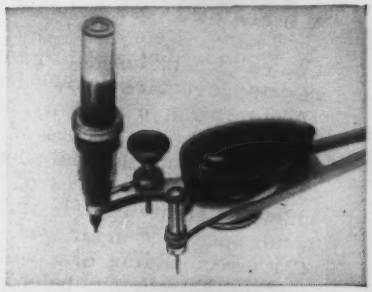
The best advice we can give for keeping current on LEROY templates is to have the LEROY catalog on hand. (It just so happens that we recently put out a brand new edition of the catalog, and it's yours for the asking. See coupon at right.) Finally, of course, we should add that if you don't see what you need in our catalog, don't despair. We'll produce it, *custom-made*, to your design – as we have done for thousands of others.

A "Built-In" Pencil Point

The business of stopping work to put a sharp point on a lettering pencil is now largely over and done with, thanks to another new LEROY item. The point of the new LEROY "020" pencil never blunts or dulls – it's permanently sharp. And that, we submit, is a pretty sharp idea. The lead of this new pencil is an unvarying .020 inches in diameter, from one end to the other. All that's necessary to repoint is to advance the lead with a turn of the pencil



shaft. No need to remove it from the scriber, by the way. This new pencil fits all LEROY scribers, and guarantees faster, smoother work. As to appearance – all lines drawn with the "020" are perfectly uniform, and of exactly the same density (a careful balance, chosen to give good wear without sacrificing print-making quality). You never saw pencil work look so good.



The Pen With A "Built-In" Inkwell

Here's your ticket to faster ink work with far fewer refills—K&E's new LEROY Reservoir Pen. You'll be amazed at the mileage you can get between refills with this newly perfected pen. Its refillable cartridge holds enough ink for many hours of smooth, uninterrupted lettering, thus eliminating the need for daily cleaning. The pen's cartridge is airtight – made of a non-porous, unbreakable, translucent material. The level of ink is always visible, and any non-solvent, waterproof India drawing ink can be used (for best results and quicker, easier filling we recommend the LEROY Lettering Ink-Cartridge #2950).

A tiny weighted needle inside the pen's feed tube assures a clear passage of ink from reservoir to point. Light vertical shaking of the pen activates this needle, removing any particles which may have settled in the tube when the pen was set aside. The needle also provides efficient cleansing action when you wash out the pen.

LEROY Reservoir Pens are furnished in seven sizes, from 00 to 5, for use with all LEROY scribers. Ideal for lettering work, the points glide easily over paper, cloth or film based surfaces, producing sharp, uniform lines that reproduce crisply.

Order Your LEROY Catalog Now

Other new additions and improvements – too numerous to go into here – are described in the new LEROY catalog. The coupon below brings your copy, free.

KEUFFEL & ESSER CO., Dept. ME-10, Hoboken, N. J.

Please send me the latest catalog on LEROY Lettering Equipment by K&E.

Name & Title_____

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CARBORUNDUM'S TECHNICAL INFORMATION ON UNUSUAL REFRACTORIES **Data sheet**

How to choose materials for

WEAR RESISTANCE

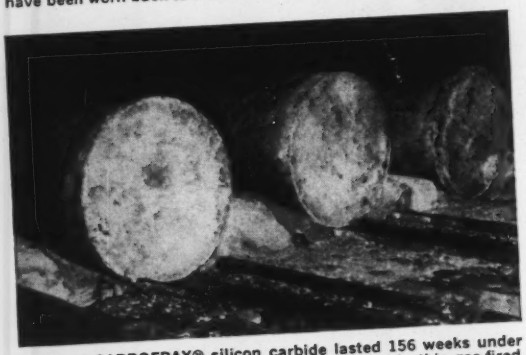
Choice of a material to give optimum wear resistance requires knowledge of type of wear (e.g. abrasion or erosion), effect on different materials, and presence of such factors as load, corrosion, thermal shock etc.

The two basic types of wear (examples shown at right) are (1) impingement of fine solids entrained in air, gas, or other fluid and (2) direct sliding of a solid mass across a surface. Effects may be erosion, primarily of the bond, thus dislodging the harder body granules; minute progressive bond fracture due to impact; or chipping, gouging or grinding of monolithic materials.

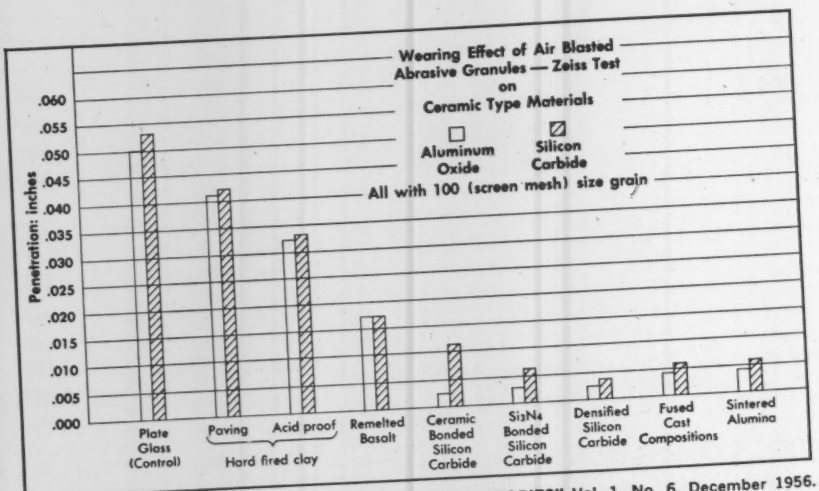
Refractories manufactured by Carborundum from electric furnace materials — such as silicon carbide and alumina — offer excellent wear resistance (see chart). Moreover, they are chemically inert, resistant to spalling, and have superior load-carrying capacity. As a result, they have found extensive use in dust collectors, gas scrubbers, transfer pipelines, hydro-cyclones, etc.

Carborundum's accumulated experience and data may help solve your wear problems. Feel free to ask for any assistance.

Abrasion by more than 2,500,000 pounds of sinter dust in 7 years has been resisted by the CARBOFRAX® silicon carbide lined cone of this primary dust collector. By comparison, other brick in the scroll and in the course between scroll and cone have been worn back to the shell, in one area after only 5 months.



Skids of CARBOFRAX® silicon carbide lasted 156 weeks under heat and the abrasion of 6¾" x 8" brass billets in this gas-fired extrusion mill furnace. Steel skids averaged only 5 weeks life.



Write today for your free copy of "Super Refractories by Carborundum." The address: Dept. ME-100, Refractories Div., Perth Amboy, N. J.

Information adapted from Chart 1, Carborundum **"REFRACTORIES"** Vol. 1, No. 6, December 1956. This bulletin, containing extensive technical information on the properties and application of refractory-type products, is published bi-monthly. Complimentary subscription on request.

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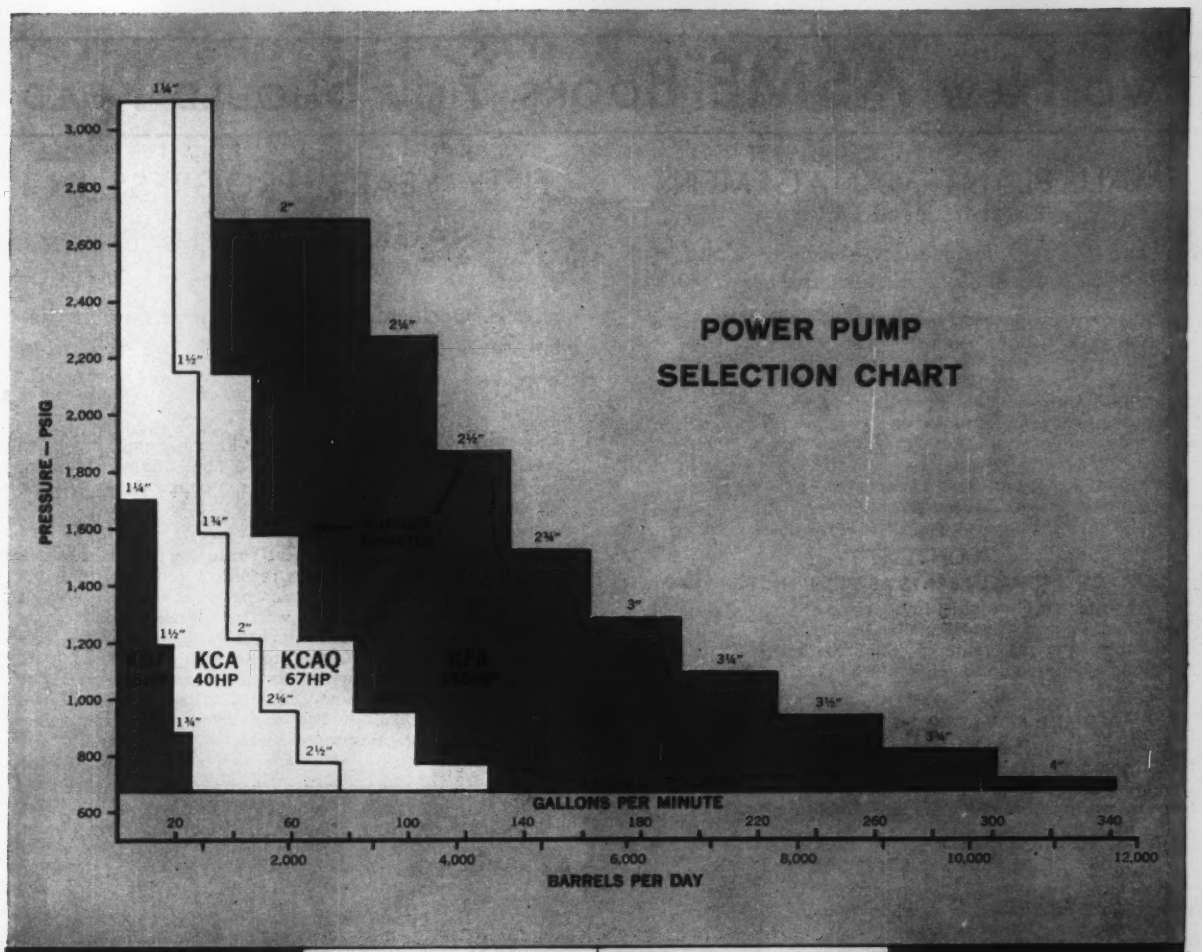

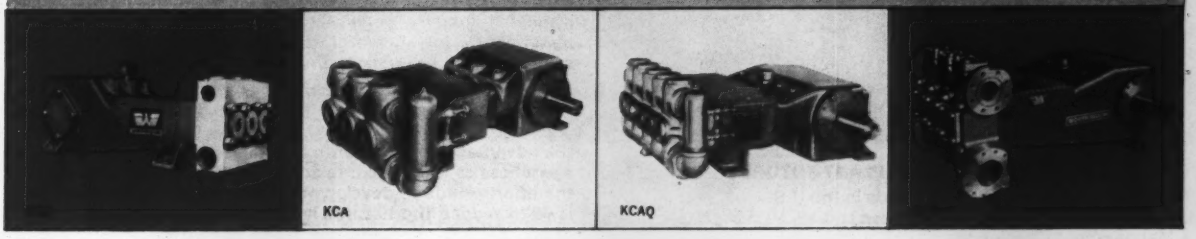

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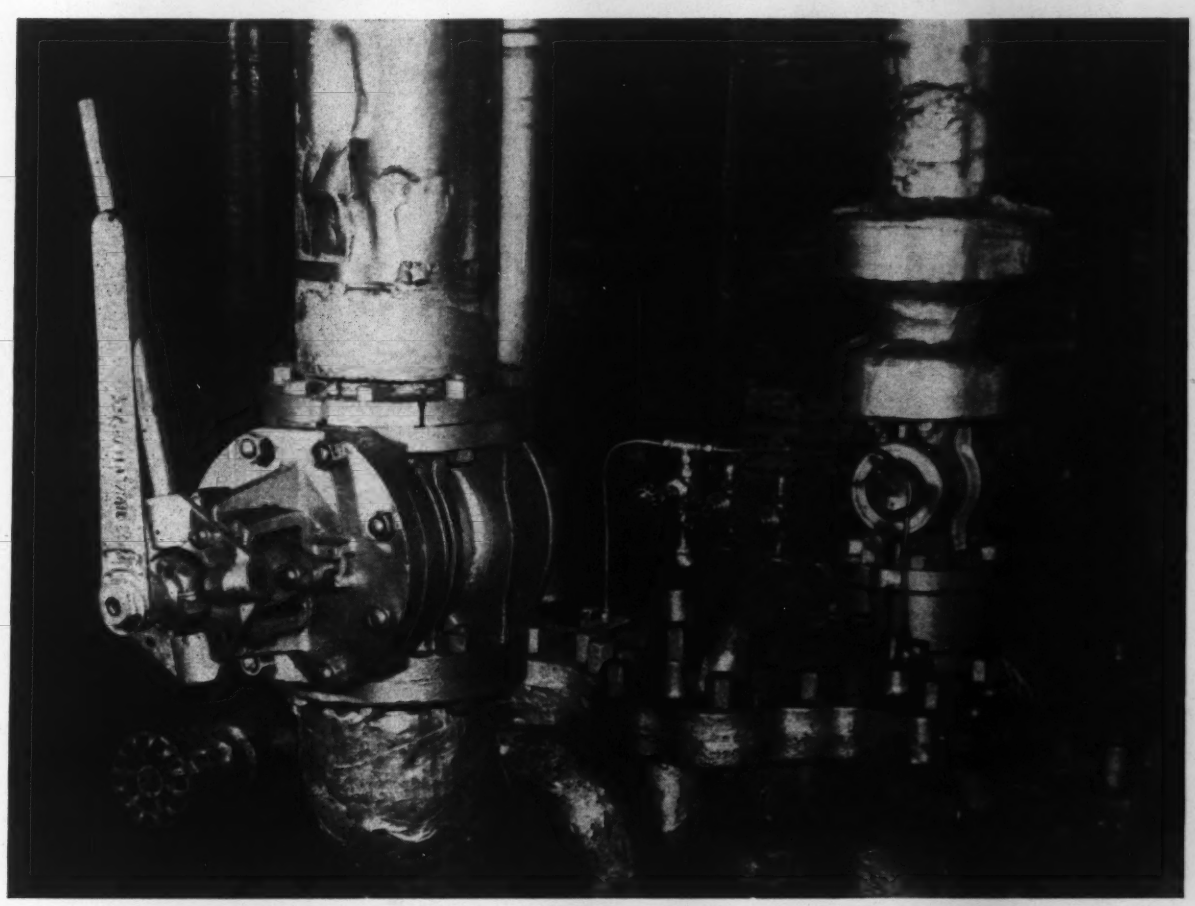

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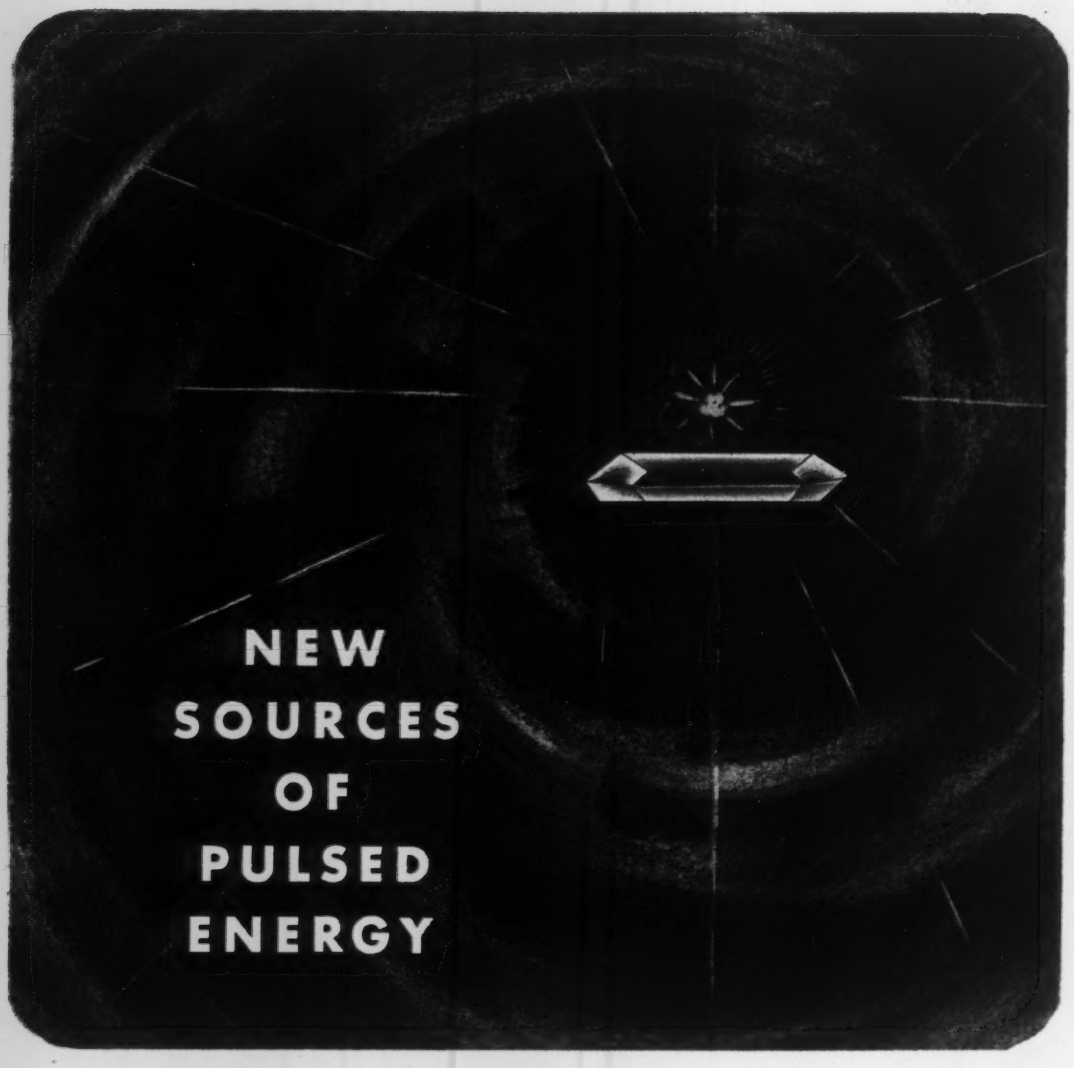

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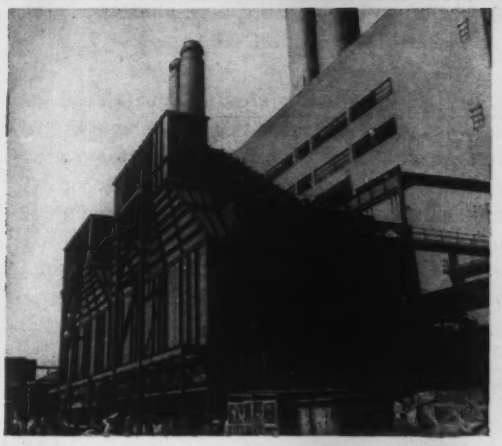

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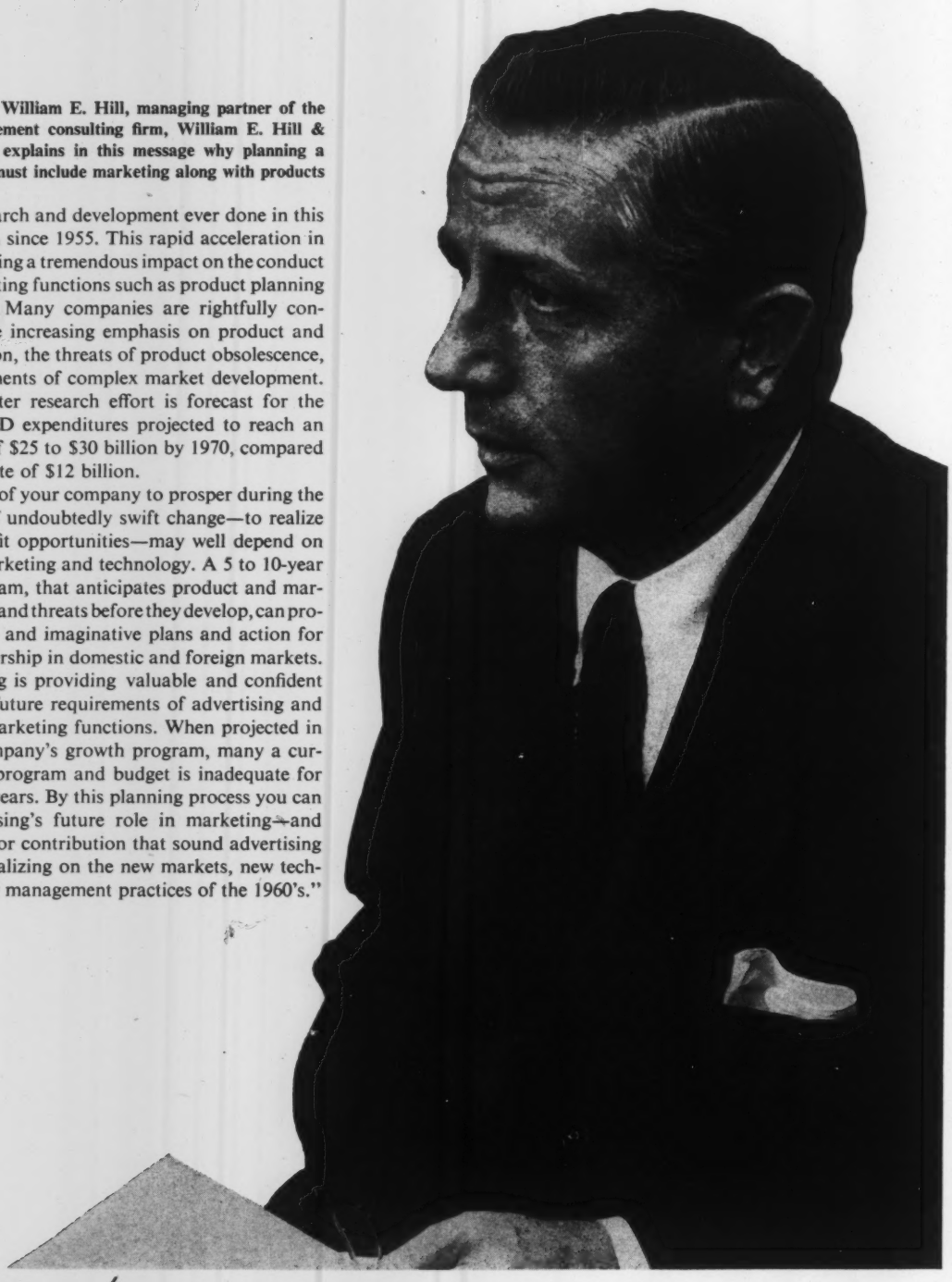

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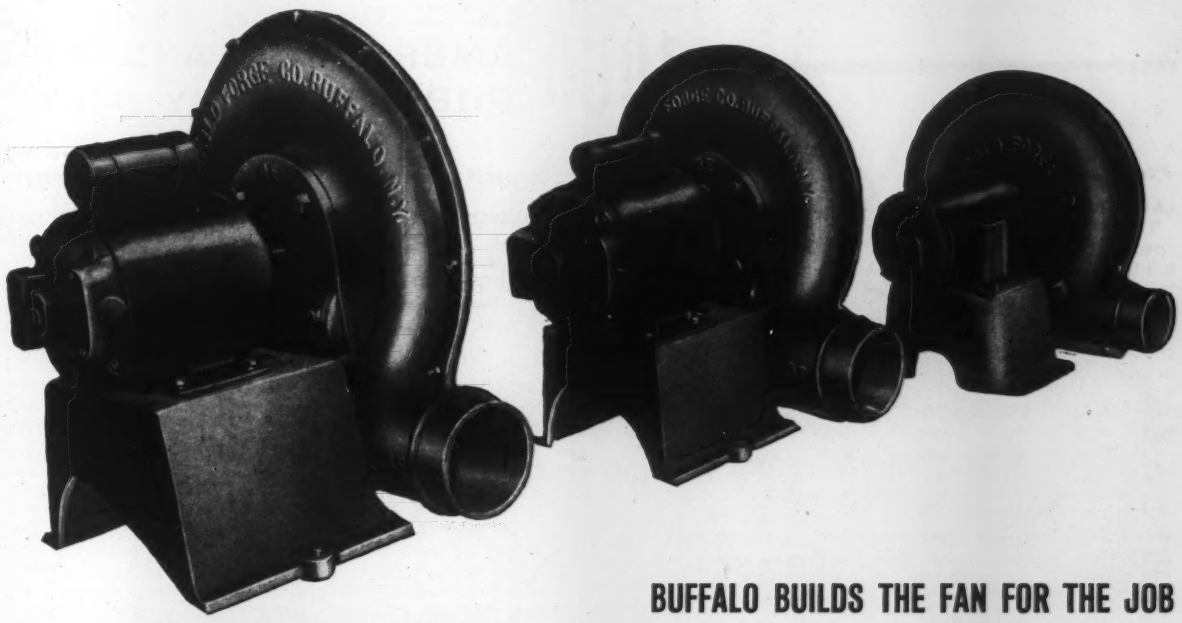

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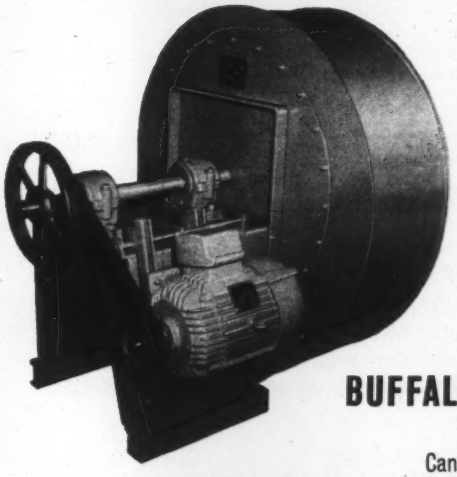

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Fasteners

LARGE RIVETS, B18.4—1960 $1.50

The proportions and dimensions, tolerances, and material specifications in this standard are for button head; high button head (acorn), flat top countersunk head, round top countersunk head, cone head, and pan head rivets in sizes from 1/2 in. to 1 3/4 in. in diameter. These types are used in structural work in bridges, buildings, etc.; and in ship and boiler construction. Length tolerances have been added to this 1960 edition.

SQUARE AND HEXAGON BOLTS AND NUTS AND LAG BOLTS, B18.2—1960 $2.00

The dimensional and material specifications in this standard are for square and hexagon bolts and cap screws, lag bolts, and nuts. Wrench openings, formulas for head and nut dimensions, specifications for a thread runout sleeve gage and ASTM and SAE grade markings for steel bolts are given in the appendixes. The grade markings is a new addition to the standard. Changes have also been made in the bolt length tolerances for certain sizes.

Pipe Fittings

CAST-BRONZE SOLDER-JOINT DRAINAGE FITTINGS, B16.23—1960. $2.00

For fittings designed for use with copper water tube, this standard gives their dimensions and tolerances; covers sizes and methods of designating openings for reducing fittings; marking, and material requirements; includes symbols for designating the type of fitting end, and sketches and designs of fittings.

CAST IRON PIPE FLANGES AND FLANGED FITTINGS:

Class 125, B16.1—1960 $1.50

Class 250, B16.2—1960 $1.50

These two standards give the approved dimensions; tolerances; sizes and methods of designating openings of reducing fittings; pressure ratings; bolts, nuts, and gasket data; requirements for materials; and marking.

Important new additions to these standards are the intermediate pressure temperature ratings and the special requirements for testing flanges which are part of or attached equipment.

1960 ADDENDA TO STEEL PIPE FLANGES AND FLANGED FITTINGS, B16.5—1957. $1.00

Here are tabulated the pressure-temperature ratings for types 304L and 316L flange series, for non-ferrous wrought flanges, and for flanges made of aluminum alloys.

Pipe Threads

PIPE THREADS (EXCEPT DRYSEAL) B2.1—1960. $3.00

Contains specifications, dimensions, and gaging of taper and straight pipe threads; definitions and symbols; data on the application of pipe threads for specific purposes; and information useful in the manufacture and measurement of pipe threads.

DRYSEAL PIPE THREADS B2.2—1960. $3.50

Included in this new standard are specifications, dimensions, and gaging of taper and straight dryseal pipe threads; letter symbols for designating dimensions of pipe thread elements, twist drill diameters for drilled hole sizes; and other useful information.

Small Tools and Machine Tool Elements

INVOLUTE SPLINES, SERRATIONS AND INSPECTION, B5.15—1960. $5.00

In this new standard data are presented in a form that pinpoints application rather than tooling problems. Specifically it provides guidance and data for the design of straight (nonhelical) involute spline teeth and involute serration teeth, presents dimensions for splines and serrations of recommended pitches; also a methodical treatment of manufacturing errors and their effect on the fit between mating parts. Spline tooth dimensions cover a range from 2.5/5 to 48/96 pitch and from 6 to 60 teeth, while the serration tooth dimensions cover the full range from 6 to 100 teeth for 10/20, 16/32, and 24/48 pitches, and a more limited range of teeth in the 32/64, 40/80, 48/96, 64/128, 80/160, and 128/256 pitches. Inspection methods; types of gages used, also their function and selection; gage dimensions and tolerances, gage blanks; measurement with pins; measurement of spline and serration errors are dealt with in considerable detail. Formulas for dimensions and tolerances, and tables on basic tooth data and on measurements between and over pins are also included.

MACHINE TAPERS, B5.10—1960. $2.50

This standard establishes American standard practice in the slope of self-holding and steep machine tapers; the dimension of this type of taper tool shank; and the corresponding dimensions for the taper socket in the spindle of the machine, including the dimensions of keyways. An appendix tabulates Brown and Sharpe tapers, and additional Morse tapers not included in the standard, also Morse stub tapers and Jarno taper data.

MILLING CUTTERS, B5.3—1960. $3.00

Covering milling cutters of one piece construction, this standard describes, illustrates, and gives the principal dimensions of 24 types of profile sharpening milling cutters, five types of form relieved milling cutters, milling cutter tolerances, dimensions of keys and keyways for milling cutters and arbors, and dimensions and tolerances for weldon shanks.

SPINDLE NOSES for Tool Room Lathes, Engine Lathes, Turret Lathes, and Automatic Lathes, B5.9—1960. $2.50

Tables give dimensions for Type A, B, D and L spindle noses, as well as for mating backs of chucks, face plates and fixtures. Also given are dimensions of gages for checking the important dimensions on these spindle noses, the backs of chucks, face plates and fixtures to insure interchangeability between parts made by different manufacturers.

In this 1960 revision tolerances for length of pilot and depth of pilot holes for Type A-1 and B-1 spindles have been decreased slightly, pilot bore diameters for some sizes of chucks, and corresponding gage dimensions changes, and the method of dimensioning radial hole locations revised.

SPINDLE NOSES AND ARBORS for Milling Machines, B5.18—1960. $1.00

Contains dimensions of the spindle noses, ends of arbors and adapters, and draw-in bolt ends.

An important new addition to this 1960 document is the table of dimensions of the spindle nose with large flange. Revisions incorporated affect certain of the essential dimensions given in the 1953 standard.

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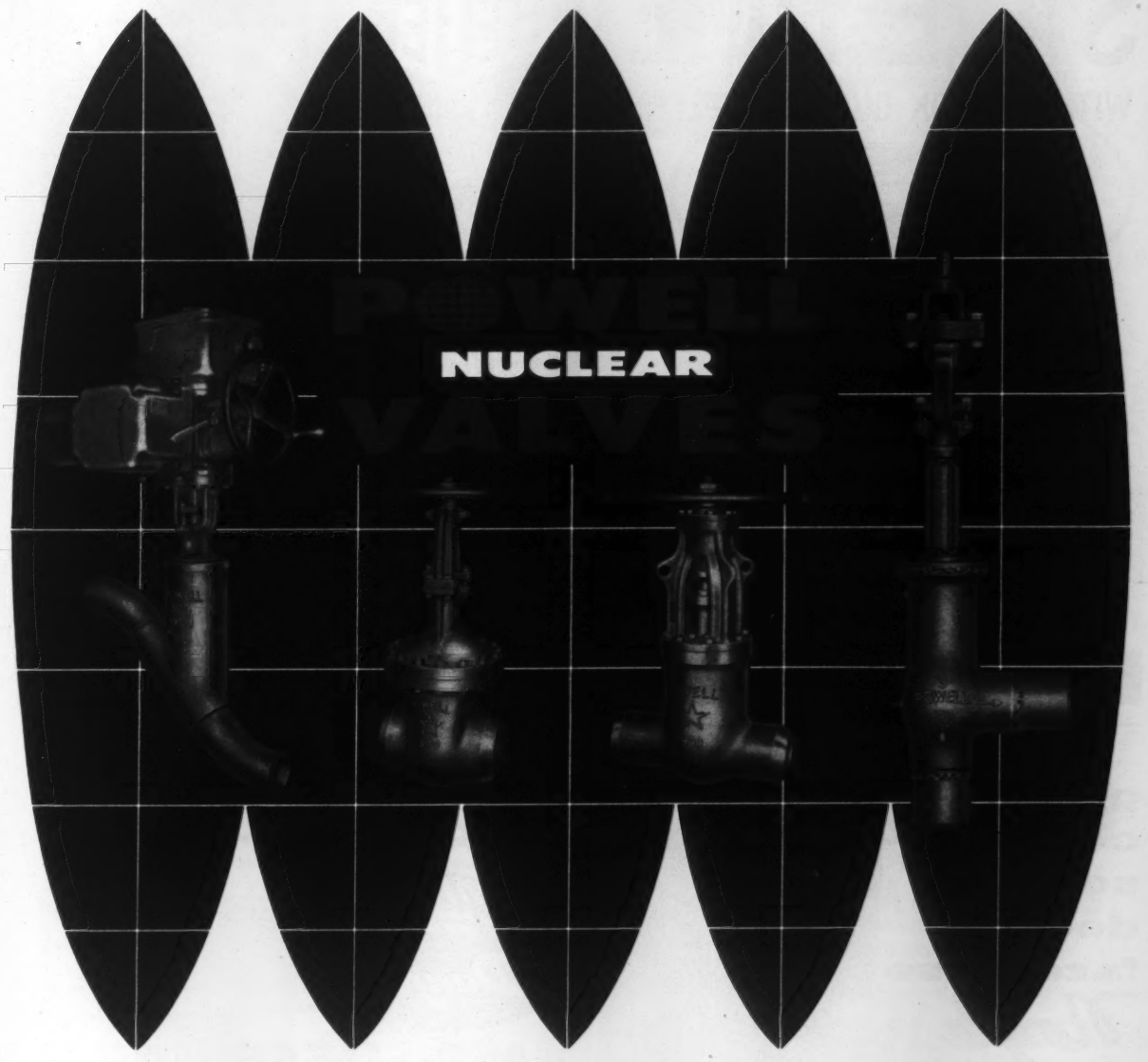

*4-inch steel Bell-O-Seal "Y" valve for 300 pounds pressure.

Fig. 3003 W. E.—Steel bolted bonnet gate valve for 300 pounds W. P. Bolted bonnet valves can be supplied for pressures from 150 through 2500 pounds.

Fig. 19003—Steel pressure seal gate valve for 900 pounds pressure. Also available in 600, 1500, 2500 pounds W.P.

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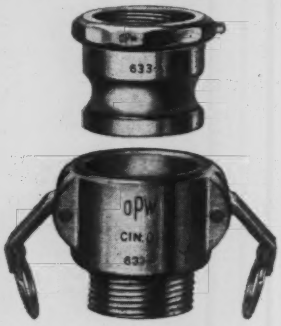

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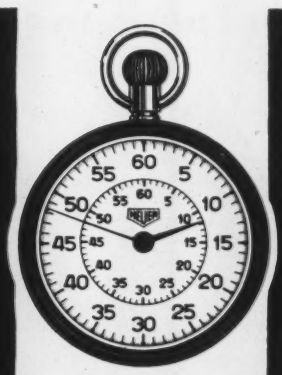

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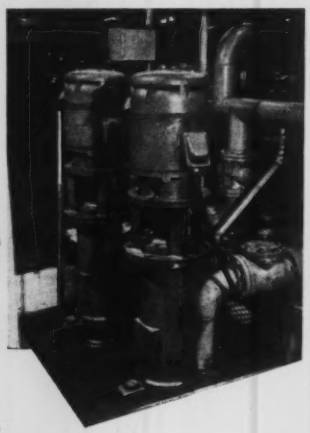

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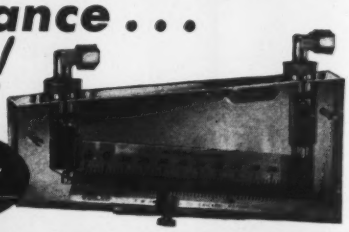

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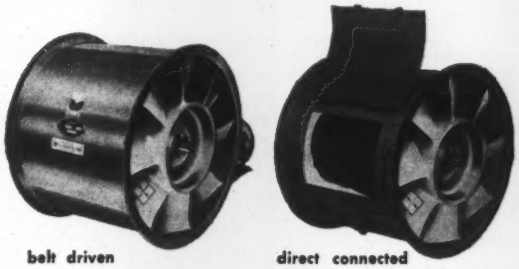

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1	Stainless Steel Ball and Race	For types operating under high temperature (800-1200 degrees F.).
2	Chrome Alloy Steel Ball and Race	For types operating under high radial ultimate loads (3000-893,000 lbs.).
3	Bronze Race and Chrome Steel Ball	For types operating under normal loads with minimum friction requirements.
4	"Dyflon"® Plastic Alloy Inserts. CRES Ball and Race. Chrome Alloy Steels.	For types operating under rotational, high radial loads and long cycle life where lubrication is impossible.

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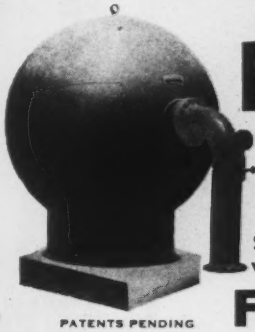

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Spherical SHOCK TRAP® for WATER LINES

Eliminate water hammer and pipeline bursting.
Save piping and plant costs with guaranteed surge limits.

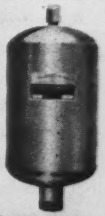
PULSCO®

Designed primarily for shut-down or shut-off application, this unit is used in pumping plants, irrigation systems, fire control on rocket test stands, municipal water systems, etc. Of the water interface type, the Pulsco swirl principle reduces pressure and reduces shock and surge resulting from kinetic energy within the pipeline, this by compressing gas within the chamber and by friction through the swirl chamber.

Guaranteed not to recycle, this Pulsco Spherical Shock Trap is built for pressures to 200 PSIG and up. Sizes from 34 to 102 inches diam.

PULSCO *Bellows* SHOCK TRAP

For AIRCRAFT AND MARINE FUEL LOADING SYSTEMS
JET FUEL AND GASOLINE



Take the "hammer" out of high velocity fuel lines — removes the danger of broken lines, meters, and overstressed loading equipment. Assure correct meter readings consistently with this Pulsco scientifically designed Bellows Shock Trap — the best for quick STOP and GO liquid lines.

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Representatives in all principal cities

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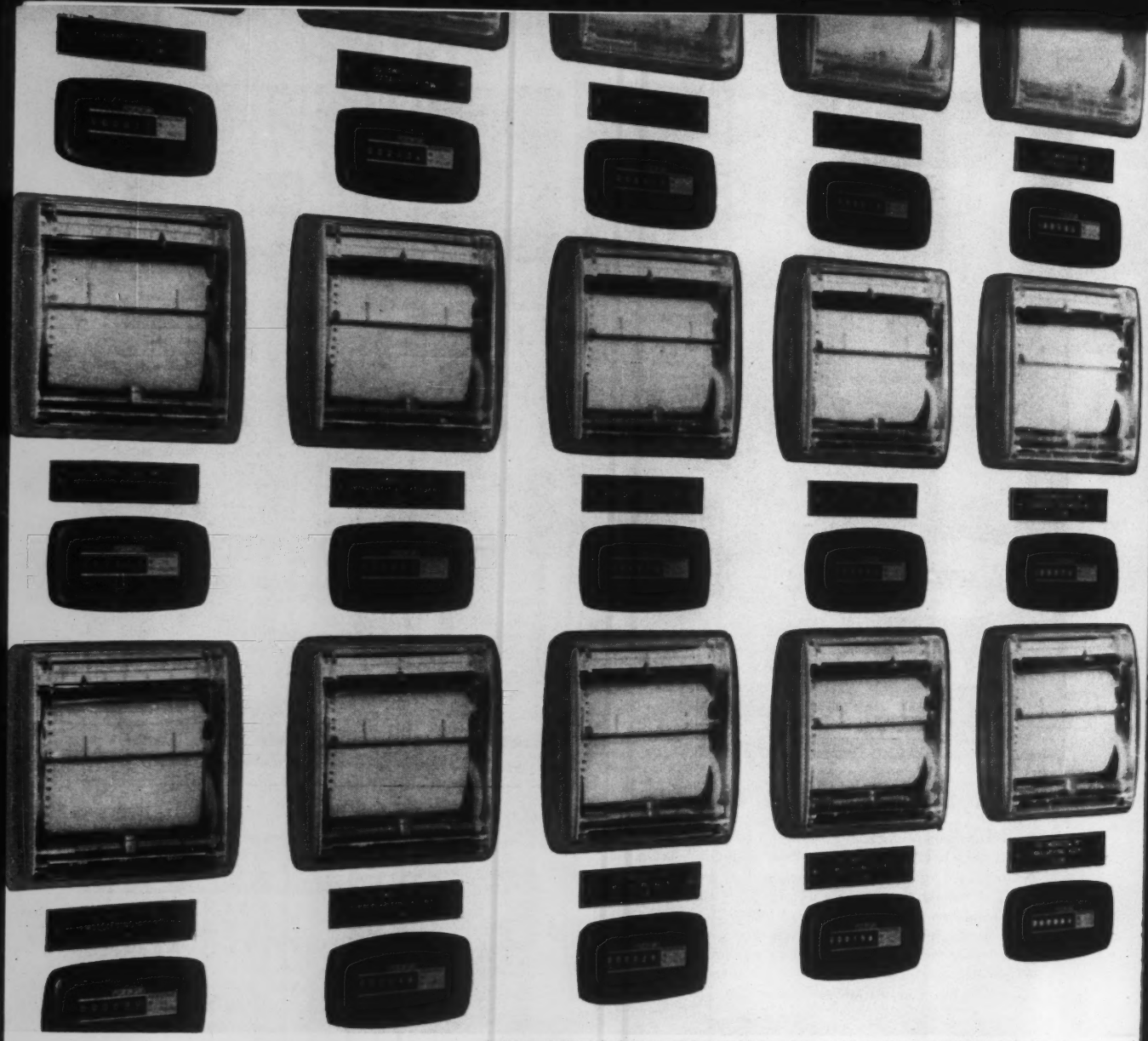
PULSATION CONTROLS CORPORATION
JAckson 5-6641



On this centralized Foxboro panel, Type 14A Integrators provide continuous totalizing of significant process and plant service flows – recorders give trend records required by operating personnel.

Simplest way to get continuous, accurate totalizing

of all process and plant service flows

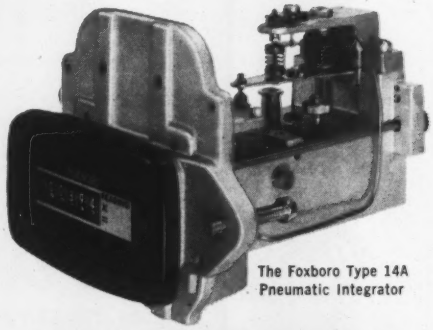
For automatic flow-accounting of all process and plant service fluids, Foxboro Type 14A Pneumatic Integrators offer unparalleled advantages of accuracy, convenience, and economy.

Easily connected to signal lines from new or existing Foxboro d/p Cell* Flow Transmitters, 14A Integrators provide **continuous** totalizing of significant flows. They can be mounted with the d/p Cell at the point of measurement, or panel-mounted hundreds of feet away.

The square root function is automatically extracted — flow totals are read directly. A simple, inherently accurate, centrifugal force system eliminates the errors of cams, special chambers, linkages, and intermittent counting.

Bulletin 13-23 fully illustrates and describes the Type 14A Pneumatic Integrator, and points the way to economical accounting of process and plant service flows. Write for your copy today. **The Foxboro Company, 9610 Neponset Ave., Foxboro, Mass.**

*Reg. U.S. Pat. Off.



The Foxboro Type 14A Pneumatic Integrator

FOXBORO

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positions open • positions wanted • equipment, material, patents, books, instruments, etc. wanted and for sale • representatives • sales agencies • business for sale • partnership • capital • manufacturing facilities

ANSWERS to box number advertisements should be addressed to given box number, care of "Mechanical Engineering," 29 West 39th St., New York 18, N. Y.

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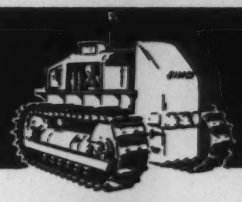

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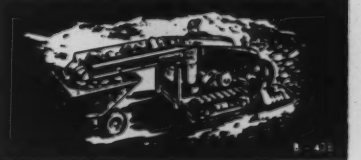

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You are invited to inquire about openings in:

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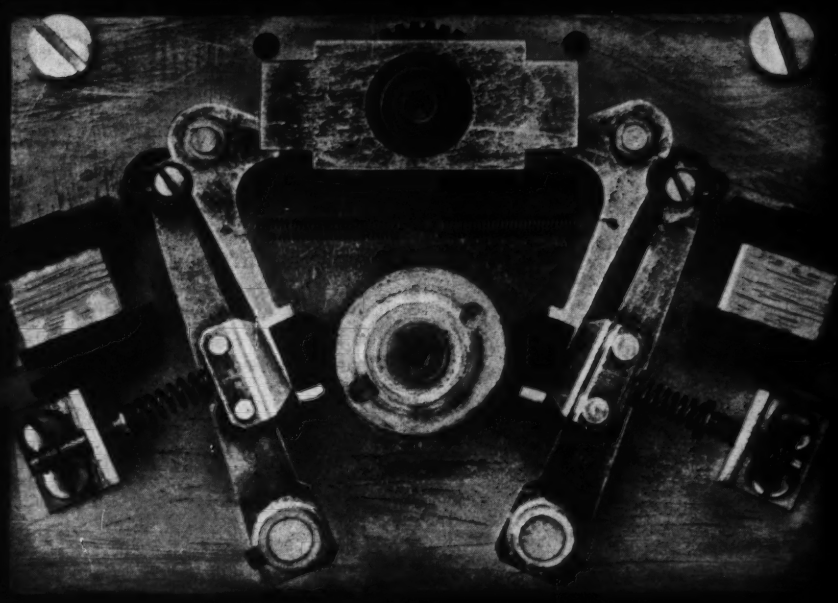
Each application will be handled in strict confidence and receive a prompt reply



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Here is a new way to convert high-speed shaft motion into precise increments, stepping forward, backward or oscillating alternately. It was developed from scratch by IBM engineers.

This truly clutchable incremental stepper provides precise control of acceleration, runs at high speed, and has great accuracy.

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IBM engineers tackled the problem of high-speed, start-and-stop motion on a theoretical basis. They analyzed the loads and accelerations involved, and decided what masses and forces would be practicable. The stepper they developed is not only more versatile and efficient than alternate methods but also gives greater life expectancy, requires no elaborate oil bath, and is easier to package into a machine assembly.

Whether it's a problem in mechanics, electronics or physical science, IBM engineers are encouraged to attack problems from fresh viewpoints. Depending on your field, you might be interested in the advances IBM people are making in magnetics, microwaves, semiconductors and inertial guidance. In every area of research and development, you will find IBM receptive to the individual who wants to make significant contributions.

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These positions require board design, coordination of customer requirements with Electrical and Optical Designers, supervision of detail draftsmen, assistance to shop during construction and assembly as well as testing and development work.

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Assistant to Vice President in Charge of Research
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Responsible for quality control functions, preventative and corrective measures for assuring good quality metal parts from parent company and vendor shops. Must have direct quality control experience, including some statistical method know-how, B.S. in mechanical or industrial engineering, with up to 3 years' experience.

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To represent an ARC affiliate manufacturing reinforced and molded plastic commercial products. Requires technical knowledge of the field, such as metal-to-metal bonding, plastic molding techniques, layups, etc. Involves liaison on customer problems, market research, sales engineering, and some travel. B.S. or M.S. in engineering with experience in plastic product development and sales engineering.

Atlantic Research Corporation is an expanding contract research and development company located in the Washington, D. C. Metropolitan area. Its technical interests range from solid propellant rocket development and manufacture, through electronics and electromechanical instrumentation, to research and development of new and improved plastic materials.

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Clarence H. Weissenstein, Director

Technical Personnel Recruitment ME

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What General Electric's Missile & Space Vehicle Department Thinks About

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"I personally feel reliability will pace our nation's space progress. Reliability is the single most important element of all our products."

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The recently headlined recovery from space of the Discoverer XIII and XIV capsules—designed and built by MSVD—continues MSVD's unbroken successes in re-entry vehicles. One of the most important factors behind these successes has been the emphasis on reliability. Such achievements in the development of reliable hardware will provide a firm basis for the conception of future satellites and space vehicles to meet the requirements of tomorrow's space missions.

MSVD Now Seeking Additional Top Reliability Engineers for Ambitious New Space Programs

5 year reliability for orbiting satellite vehicles is our immediate objective. This represents an increase in reliability of *many orders of magnitude*. On this and similar programs, MSVD offers Reliability Engineers wide authority over complex programs—many of which they'll originate. Theirs is a predictive science which they must mesh with the work of the design and development engineers.

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Communications Satellite
NERV (Nuclear Emulsion Recovery Vehicle)
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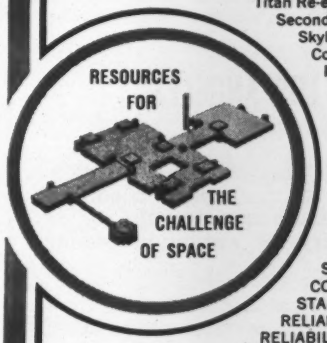

Reliability Engineers capable of original contributions in an environment that takes full advantage of their talents are invited to investigate opportunities with MSVD in the following categories:

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COMPONENT ENGINEERS
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ENGINEERING CHAIRMAN—DESIGN CHANGE BOARD

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An appreciation for or interest in human factors aspects of engineering is desirable. B.S. to Ph.D. and ability to write good reports or contributions thereto is required. Past experience relating to the preparation of research proposals would be helpful. These positions are non-routine and require men with inititative and resourcefulness.

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1961 MECHANICAL CATALOG 50th Edition

PRODUCT DATA SECTION Here, leading manufacturers supply latest technical information and specification data on their indexed products.

ASME PUBLICATIONS SECTION All available material on ASME Codes, Standards, Periodicals, and other publications is described in the 1961 Catalog of Publications.

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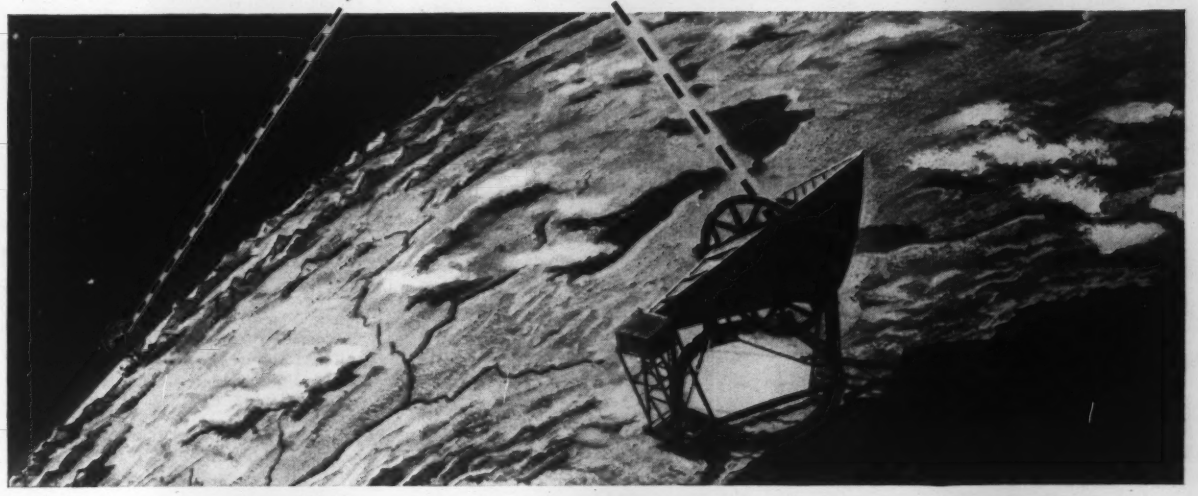


BELL TELEPHONE LABORATORIES BOUNCES VOICE OFF SPHERE PLACED IN ORBIT A THOUSAND MILES ABOVE THE EARTH

Think of watching a royal wedding in Europe by live TV, or telephoning to Singapore or Calcutta—*by way of outer-space satellites!* A mere dream a few years ago, this idea is now a giant step closer to reality.

Bell Telephone Laboratories recently took the step by successfully bouncing a phone call between its Holmdel, N. J., test site and the Jet Propulsion Laboratory of the National Aeronautics and Space Administration (NASA) in Goldstone, California. The reflector was a 100-foot sphere of aluminized plastic orbiting the earth 1000 miles up.

Dramatic application of telephone science

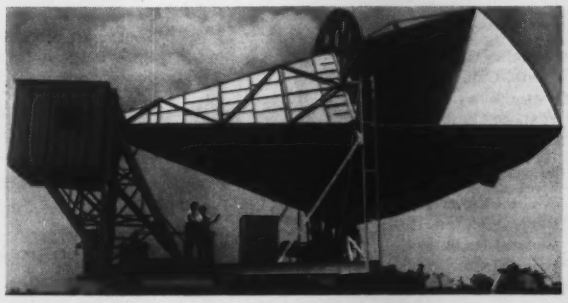
Sponsored by NASA, this dramatic experiment—known as "Project Echo"—relied heavily on telephone science for its fulfillment . . .

- The Delta rocket which carried the satellite into space was steered into a precise orbit by the Bell Laboratories Command Guidance System. This is the same system which recently guided the remarkable Tiros I weather satellite into its near-perfect circular orbit.

- To pick up the signals, a special horn-reflector antenna was used. Previously perfected by Bell Laboratories for microwave radio relay, it is virtually immune to common radio "noise" interference. The amplifier—also a Laboratories development—was a traveling wave "maser" with very low noise susceptibility. The signals were still further protected from noise by a special FM receiving technique invented at Bell Laboratories.

"Project Echo" foreshadows the day when numerous man-made satellites might be in orbit all around the earth, acting as 24-hour-a-day relay stations for TV programs and phone calls between all nations.

This experiment shows how Bell Laboratories, as part of the Bell System, is working to advance space communication. Just as we pioneered in world-wide telephone service by radio and cable, so we are pioneering now in using outer space to improve communications on earth. It's part of our job, and we are a long way toward the goal.



Giant ultra-sensitive horn-reflector antenna which received signals bounced off the satellite. It is located at Bell Telephone Laboratories, Holmdel, New Jersey.

BELL TELEPHONE LABORATORIES
WORLD CENTER OF COMMUNICATIONS RESEARCH AND DEVELOPMENT

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364 TONS OF FRICK REFRIGERATION . . .

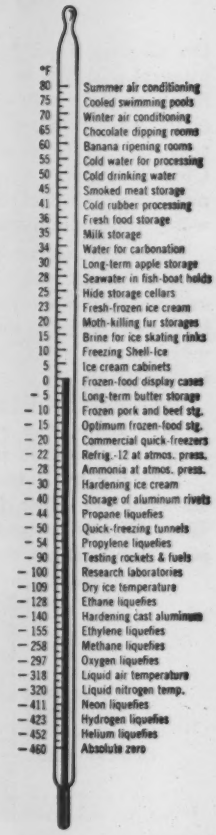
PRODUCE PROFITABLE YIELD OF PROPANE, BUTANE AND NATURAL GASOLINE

● The location: about 30 miles north of Lake Charles, Louisiana. The plant: the Upper Bearhead Creek Sand Unit, operated by H. L. Hunt. The refrigeration equipment: designed and manufactured by the Frick Company.

This is only one of several dozen natural gasoline plants equipped by Frick. Here, as in others, rich casinghead gas is compressed to 950 Psig. and then dehydrated with the temperature being lowered to about 0° F. in a gas chiller that uses ammonia as the refrigerant. This way, hydrocarbon liquids are condensed and then fractionated into Propane, Butane and natural gasoline.

If you have a refrigeration problem of *any* type, Frick has the answer. A Frick engineer will call and discuss it with you at your convenience. No obligation at all. Write:

FRICK COMPANY
Waynesboro, Pennsylvania


°F
80 Summer air conditioning
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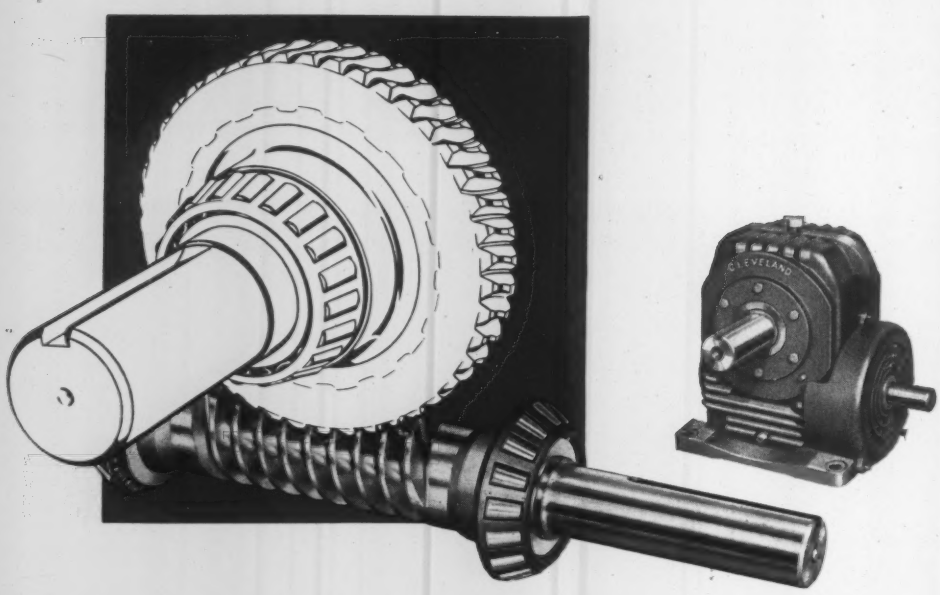


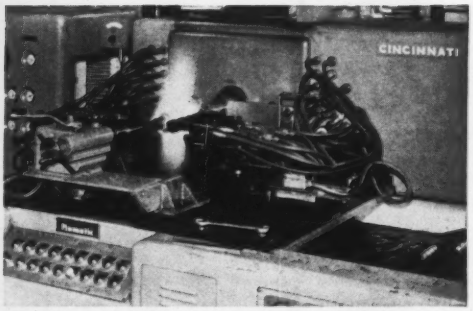
Flamatic-hardened worms help give Cleveland Speed Reducers their longer service life . . .

On all Cleveland Speed Reducers, alloy steel worms are cut integral with the shaft and accurately ground to a high surface finish on both thread flanks. Shaft extension diameter is especially large to permit increased overhung load capacity. Heat treatment is by a special "Flamatic" process—exclusive with Cleveland-made worms. This provides a high degree of hardness throughout the entire thread thickness and well below the worm's root diameter—(See etched worm cross-section).

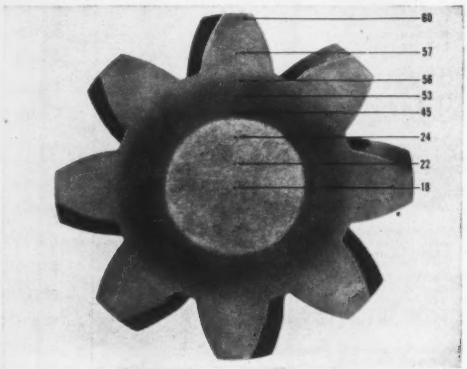
This new worm hardness pattern gives maximum thread strength and resistance to wear without sacrificing the advantage of a medium-hard tough core. Furthermore, the pattern is carried out in the worm shaft extension past the oil seal wearing surface to prevent the shaft being worn and damaged by its oil seal.

Mated with Cleveland's high density centrifugally cast bronze gears, the result is increased wear resistance—much longer trouble-free service life.

Why not write today for your free copy of Bulletin No. 405 showing the latest developments in the Cleveland Worm Gear Line. Or, better yet, contact your nearest Cleveland Representative and get the complete facts.



Worms are Flamatic-hardened in the Cleveland Plant (above) to give them the typical Rockwell "C" hardness pattern as shown in the etched cross-section (below).

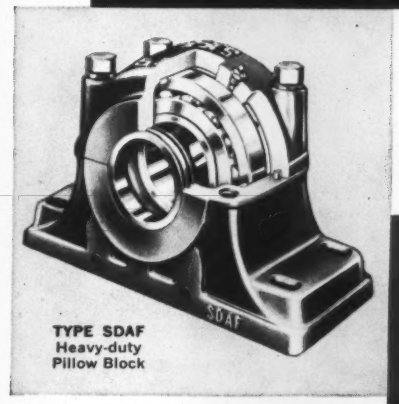


CLEVELAND
Worm Gear
Speed Reducers

Cleveland Worm & Gear Division
Eaton Manufacturing Company
3264 East 80th Street • Cleveland 4, Ohio

TYPE SAF
Ball or Spherical Roller
Bearing Pillow Block

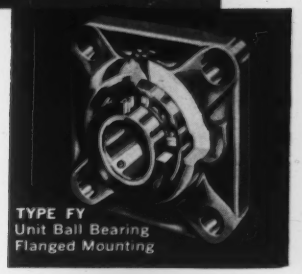
Can you get these "special" qualities in "standard" pillow blocks?



TYPE SDAF
Heavy-duty
Pillow Block

TYPE SY
Unit Ball Bearing
Pillow Block

TYPE SES
Unit Rubber-flex Ball
Bearing Pillow Block



TYPE FY
Unit Ball Bearing
Flanged Mounting

Most pillow blocks offer easy assembly and rugged housings. But can they offer you low friction, self-aligning bearing operation and efficient sealing as well?

They can—if they're the SKF pillow blocks, and flanged mounting, shown here. Type SAF, for example, comes equipped with low-friction ball or spherical roller bearings that are *inherently* self aligning. And these bearings are effectively protected by Triple-Seal rotating rings. Abrasives and corrosives can't get to them—oil or grease can't drip out.

Yet this is a standard SKF pillow block, that is competitively priced in spite of its combination of extra features. We make it for shaft sizes from ¾" to 10½", for mounting directly or with an adapter. A cast steel housing (SAFS) is available for heavy duty applications.

For details, call one of our twenty-five offices. 5938

Spherical, Cylindrical, Ball, "Tyson" Tapered and REED Miniature Bearings

EVERY TYPE—EVERY USE

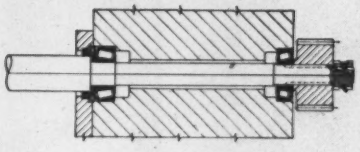
SKF®

SKF INDUSTRIES, INC., PHILADELPHIA 32, PA.

*REG. U.S. PAT. OFF.

Why Cross chose Timken® bearings for all 148 drill spindles

How **THE CROSS CO.** mounts 148 drill spindles of its Transfermatic machine on Timken bearings to give longer bearing life, maintain accuracy.



THIS huge Cross transfer machine drills and taps holes in automobile engine blocks at new highs in speed and accuracy. To assure maximum user economy and machine life, Cross engineers chose Timken® tapered roller bearings for the machine's 148 drill spindles. Here's why:

1) *They maintain precision longer.* Timken bearings are geometrically designed to give true rolling motion, precision manufactured to live up to their design.

2) *They're extra tough* because Timken bearings are made of the finest bearing-quality alloy steel available.

When you use a machine with Timken bearings, you get all the *extra* benefits of Timken Company leadership in tapered roller bearing design and in engineering service. We maintain the industry's most modern laboratory to test bearing applications. To get better machines, make sure they're Timken bearing-equipped. ***When you buy Timken bearings you get...*** 1) *Quality you can take for granted.* 2) *Service you can't get anywhere else.* 3) *The best-known name in bearings.* 4) *The pace setter in lower bearing costs.* The Timken Roller Bearing Company, Canton 6, O. Cable: "TIMROSCO". *Makers of Tapered Roller Bearings, Fine Alloy Steel and Removable Rock Bits.* Canadian Division: Canadian Timken, St. Thomas, Ontario.

Industry rolls on

TIMKEN®

tapered roller bearings